THE TELEGRAPHIC JOURNAL AND

Electrical Review.

Vol. XII.—No. 279.

THE ROYAL AQUARIUM ELECTRIC LIGHT EXHIBITION.

The date originally fixed for the opening of this exhibition was the 1st of November last, but, owing to frequent and unavoidable delays, it was not until the 3rd inst. that it was deemed ready for public inspection; it was not even then by any means complete. Substantial progress has, however, been made since, many more exhibitors having come forward. The exhibits have now all been properly adjusted, and the various apparatus may be seen in action nightly. Following are accounts of some of the more important exhibits:—

J. & W. E. Archbutt, Westminster.

The stand of the Messrs. Archbutt, which is apparently a great attraction to a very large number of the Aquarium visitors, is neatly fitted up with a large assortment of electric bells for house purposes.

J. Bourne & Son, Denby Pottery, near Derby.

Messrs. Bourne, who are manufacturers of the well-known stone-ware telegraphic insulators and battery jars, which, it is said, have for thirty years "been celebrated for a high degree of vitrefaction, combined with great toughness and strength," exhibit an excellent selection of porous cells, insulators, &c.

The British Insulite Company.

A new insulating material known as "Insulite" is exhibited by this company.

Davey, Paxman & Co., Colchester.

This firm exhibits, in annexe B., in the north-east corner of the building, a compound engine of excellent design for electric lighting. It drives two Lumley dynamos, and is said to consume less than 3 lbs. of coal per hour per H. P. The engine is supplied with one of Messrs. Kenyon's rope driving pulleys, and also a friction clutch, for throwing it quickly in and out of gear. One of these dynamos feeds five arc lamps in series and the other, seventy incandescent lamps. This company has also a 25-horse-power engine in annexe A., in a temporary shed in the north-west corner of the Aquarium. In the same shed is one of the firm's 30-horse-power cylinder engines, having two separate boilers to supply the requisite steam. The two engines, which drive on the same shaft, supply the motive power for working the dynamos required for Messrs. Edmundson & Co.'s Swan lamp exhibit, and a number of Jablochkoff lamps, besides driving two Elphinstone and Vincent machines.

Edmundson & Company.

An excellent selection of Swan lamps, in all about 220, is shown by this firm, who are agents for the Swan Company. Their exhibits include a billiard chandelier with 18 lights of 20 candle-power each; an elegantly-appointed drawing-room in which are fitted up a 15-light chandelier, and brackets to half lamps of 10 candle-power, and five others of 20 candle-power. The lamps in the drawing-room are supplied by a Siemens dynamo, which is driven by an Otto gas-engine, the gas for which is manufactured by special process of the Dowson Economic Gas Company.

The Electrical Rotary Brush Company

Shows an ingenious application for revolving brushes for brushing hair and other purposes.

The Electrical Trading Company.

The exhibits of this firm include Boys' integrating machines or meters—electric energy meter, electric current meter and engine-power meter—and also Messrs. Berthold & Borel's lead-covered cables, Swiss chronograph watches, calculating circle, and an electrical condenser.

Paterson & Cooper, London.

In annexe A this firm has two Elphinstone-Vincent generators. They are multipolar dynamo machines, one of which feeds 350 Swan lamps in Messrs. Bertram & Roberts' smoking gallery, in groups of fifty, in electroliers, and the other the large light of 100,000 nominal candles, which for some time burned very badly, but has now been much improved. Although these machines may be kept running for hours continuously, the bearings keep comparatively cool. This machine, from its efficiency, is the great antagonist of the Ferranti-Thompson machine, which also drives the same number of lights for the *table d'hôte*.

Gaulard & Gibbs

Exhibit two induction machines for the production of currents of different tension, so that without disturbing the primary current arc lamps or incandescent lamps can be burned in any adjacent position. This is said to be accomplished on the principle of the Ruhmkorff coil. The original currents traverse a primary coil, and, in so doing, induce currents in a number of enveloping coils. If these latter coils are joined in "series" a high-tension current is derived, while joining them in parallel circuit causes a low tension current to be developed. The loss in conversion of current will, it is stated, be compensated for by the increased convenience of distribution.

W. T. Glover & Co., Manchester.

As is known to most of our readers, Messrs. Glover & Co. are manufacturers of wire and cables of every description for telegraphic, telephonic, and electric lighting purposes; and on the stand of this company at the exhibition are to be seen many excellent specimens of their manufacture.

W. H. Grant, Foleshill, Coventry.

Mr. Grant exhibits an electric loom, worked by Edison's motor, which weaves portraits of Mr. Edison.

W. T. Henley's Telegraph Works Company, Limited.

Specimens of submarine cables and conductors of all kinds are exhibited in great variety at the stall of this company.

Hodson's Rotary Engines.

These are shown in annexe B. Various sizes are running, and drive Schükert's dynamo supplying the Joel lamps under the Grill Gallery; Siemens' shunt dynamo, feeding

eight Pilsen lamps in the main hall; a new small Brush dynamo feeding twenty new lamps, and one Mathieson's dynamo supplying arc lamps of high candle-power, one of which illuminates Messrs. McEvoy & Mathieson's court and also the transept. Another rotary engine drives one of Siemens' dynamos, which transmits power to the Griscom motors in charge of Mr. Heap.

THE JABLOCHKOFF ELECTRIC LIGHT AND POWER COMPANY, LONDON.

In annexe A, in the temporary building in the north-west corner, this company, who are the contractors to the Metropolitan Board of Works, and in this capacity light the Thames Embankment and the Waterloo Bridge, have a Jablochkoff self-exciting Gramme, supplying 10 double "candles" on standards and 24 incandescent lamps in the body of the hall, both of which give an excellent light.

MCEVOY & MATHIESON.

Captain McEvoy and Mr. Mathieson occupy one of the courts, and exhibit various electrical apparatus connected with submarine mines, torpedoes, field telegraphy, &c. McEvoy's portable military telegraph apparatus, which is a very ingenious contrivance, generates the current as required for use simply by the movement of the key in working. It being a magneto machine no battery is required, a telephone taking the place of the Morse sounder. It can be carried in the pocket, and is admirably adapted for military field work. Another novelty is a little apparatus for tapping telegraph wires, by means of which a message can be distinctly heard when in course of transmission.

J. L. PULVERMACHER, LONDON,

Exhibits improved galvanic chain-bands, belts and chain-batteries, which are said to be endowed with a powerful electric tension, and to be very useful for medical purposes.

ROBEY & CO., LINCOLN,

Show in annexe B 16 horse-power engines which drive a Siemens alternating-current dynamo, supplying 26 differential arc lamps in the main hall, six of them being in the well-known chandelier exhibited at Paris and also at the Crystal Palace.

F. A. STEVENS, WEST SMITHFIELD,

Shows a variety of electric bells, indicators, batteries, &c.

THE UNITED ASBESTOS COMPANY, LONDON.

By its exhibits this company shows the many uses to which asbestos can be applied.

C. F. & F. H. VARLEY, LONDON.

Among the special exhibits of this firm is the Varley Patent Flexible Carbon Candle. This candle, according to the information supplied to us by Messrs. Varley, gives what has not hitherto been obtained—a perfectly luminous arc, and at least four times the light of any known candle. The light is rich, warm, and sunlike. When burned in contact there is an entire absence of noise, and on account of its flexibility it can be made into coils of any length, and paid out like the wick of an ordinary lamp. The full results to be obtained by these candles are yet but imperfectly known. The field they open for subdivision of the arc, however, may be imagined from the following experiments which have been made at the stand of Messrs. Gaulard & Gibbs: An arc of $\frac{1}{4}$ in. in length was obtained from candles of 3-16 of an inch in diameter, with a current of $1\frac{1}{2}$ ampères and a potential of 25 volts. An arc $\frac{7}{8}$ of an inch long was obtained from candles $\frac{7}{8}$ of an inch in diameter, with a current of 5 ampères and a potential of 50 volts. An extraordinary arc of $\frac{7}{8}$ of an inch in length was obtained from cased specimens of 9-16 of an inch in diameter, with only $2\frac{1}{2}$ ampères of current and a potential of 15 volts.

The Varley patent accumulator is made of carbon specially prepared by a process invented by Mr. Frederick Henry Varley. Chief among its advantages are its great storage capacity combined with lightness of weight and smallness of bulk. As compared with the Faure accumulator, it is confidently claimed that weight for weight it has at least twenty times the storage capacity.

The Varley-Shearer patent electric meter, another exhibit of Messrs. Varley, which is the joint invention of Mr. Frederick Henry Varley and Mr. John Roland Shearer, may be said to have made general electric lighting possible. It can be constructed to give a record in ampères only, or in volts only, or in both ampères and volts. It is simple in construction, neat in design, and perfectly intelligible to everybody; and as regards accuracy, it is said to be as nearly perfection as possible.

As the result of these three inventions the consumer may, it is stated, have a perfect lamp, independent of niceties of regulation, fed from an accumulator fixed and charged on his own premises, like his water cistern, in combination with an electric meter at once accurate and easily read. We cannot, however, speak with authority on this portion of Messrs. Varley's apparatus at present.

The other exhibits include the Varley arc and contact lamp, double current keys, P. O. pattern, and Varley's improved form; F. H. Varley's railway block system, testing keys, switches, vacuum lightning protectors; Sir William Thomson's slides, with Varley's sub-divider, astatic and mirror galvanometers, and electric speed recorders.

In addition to those already mentioned, a dynamo machine on the Gramme type is shown by Mr. Mathieson; the Lumley machine, also of the Gramme type, by Messrs. Paterson and Cooper; and the well-known generators by Siemens, Schuckert, Gramme, Bürgin and Brush.

THE THOMSON-HOUSTON ELECTRIC LIGHTING SYSTEM.

THIS system, at present confined to America, is based upon the joint patents of Elihu Thomson and Edwin J. Houston, and also upon separate patents of the former, the whole including all the necessary appliances for a complete electric lighting plant.

A description and illustration (fig. 1) of the Thomson "spherical" dynamo-electric machine, which we find in a pamphlet issued by the American Electric Company, may probably be found sufficiently interesting to afford our readers some slight idea of Mr. Thomson's invention.

The generator is known as the "Thomson spherical," from the nearly spherical form of its armature, and differs radically from any others in all essential portions, viz., its field magnets, armature, and winding thereof, and in its commutator; both in principle and construction, and, besides, it is provided with an automatic regulator, an attachment not applied to other generators.

The revolving armature is made internally of a hollow shell of soft iron secured to the central portion of the shaft between the bearings, and is wound externally with a copper conducting wire, constituting three coils or helices surrounding the armature, which coils are, however, permanently joined, and in reality act as a single three-branched wire.

This wire, being wound on the exterior of the armature, is fully exposed to the powerful magnetic influence of the field poles, which enclose the armature almost completely. The armature is thus thoroughly encased and protected, and at the same time all the wire upon it is subject to a powerful action of the surrounding magnets, resulting in an economy in the generation of current in its coils. The form of the armature being spherical, very little power is lost by air friction, and no injury can occur from increased speed developing centrifugal force. The field magnets, which surround the armature, are cast-iron shells, wound outside with many convolutions of insulated copper wire, and are joined externally by iron bars. These outer bars also serve as a most efficient protection to the wire and armature of the machine during transport, &c. Objects cannot fall upon or rest upon the wire coils and injure them. The coils of wire upon the field magnets surround, not only the iron poles or shells, but are also placed so as to surround likewise the revolving armature, which is said to increase the effect produced in it by direct induction and magnetism. This feature is not used in any other generator, nor does any other make use of a spherical armature. The shaft is mounted in bearings of ample size, and is of steel, finely turned and perfectly true. The shaft and armature together are balanced with the utmost care, and run without noise. The armature wire is kept cool by an active circulation of air over its whole surface during revolution. The commutator is mounted upon the

end of the shaft, and has attached to it the wires (three only) coming from the armature wire through the tubular shaft.

The commutator is peculiar, consisting of only three segments of a copper ring, while in the simplest of other continuous-current generators several times that number exist. These three segments are made so as to be removable in a moment for cleaning or replacement. They are mounted upon a support, and are surrounded by a free air space, and cannot, therefore, lose their insulated condition This feature of air insulation is peculiar to this system, and

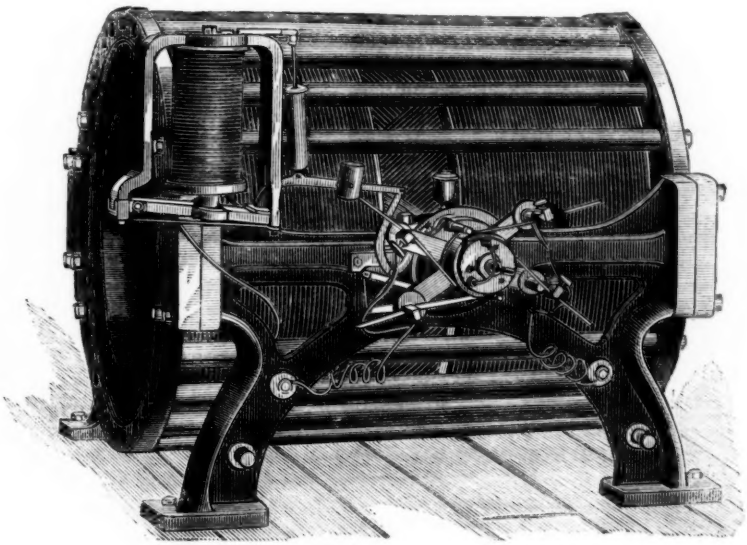


FIG. 1.

is very important as a factor in the durability of the commutator. Besides this, the commutator is sustained by supports carried in flanges upon the shaft, which flanges, as an additional safeguard, are coated all over with hard rubber. The three commutator segments virtually constitute a single copper ring, mounted in free air, and cut into three equal pieces by slots across its face. Four slit copper springs, called commutator brushes or collectors, are allowed to bear lightly upon the commutator when it revolves, and serve to take up

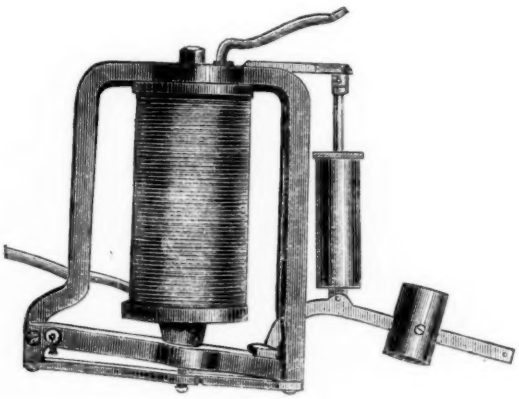


FIG. 2.

the current and convey it to the circuit. These commutator brushes are carried by movable supports, and their position is automatically regulated so as to control the strength of the developed current—a feature not found in other systems. This feature, as well as the fact that the commutator can be oiled to prevent wear, saves attendance and greatly increases the durability of the wearing surfaces, while the commutator brushes are maintained in the position of best adjustment. The commutator and brushes, in consequence, after weeks of running, show scarcely any wear.

The Automatic Current Regulator.

This consists of a peculiar magnet attached to the frame of the generator, and the movable armature of which has connections to the supports of the commutator brushes for controlling their position. The regulator magnet is so formed as to give a uniform attraction upon its armature in different positions. In Thomson's improved form this is accomplished in a novel manner by making the pole of the magnet paraboloidal in form, and making an opening in the movable armature to encircle the pole.

The armature is hung on pivots (fig. 2) so as to be free to move only towards and from the regulating magnet on changes in the current traversing the latter, and being connected to the commutator brushes automatically adjusts their position. By this means the power of the generator is adapted to run any number of lights within its limit of capacity, or it may be short-circuited purposely or by accident without difficulty arising therefrom; a number of instances have occurred where the injurious effects of a short-circuit accidentally formed have been entirely obviated

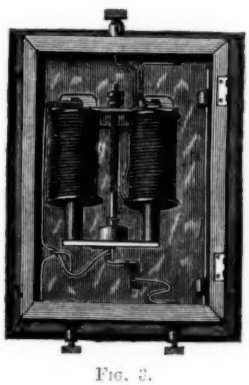


FIG. 3.

by the presence of the regulator. In one instance four generators, in series, representing over forty lights' capacity, were accidentally short-circuited, and no injury or even noticeable action took place except a quick movement of the regulators in adapting themselves to the new conditions. Had this accident occurred to generators unprovided with regulators, great injury or possible destruction of the apparatus would have resulted. It is important to a full understanding of the regulation, to state that its action is independent of resistances introduced, that it saves power and carbons in proportion to lights extinguished, and that it

compensates for speed variations from the normal speed. The manner of its action is to control the generation of current at the source in the armature, and it does so by combining certain electrical actions so as to obtain a differential effect, such that when a small force of current only is required it alone is furnished, and when the maximum force is needed the same shall be forthcoming. On the larger generators is combined with the regulator magnet above described, an exceedingly sensitive controller magnet governing the regulation, and by whose means the smallest variations of current are counteracted, and the operation of the generator rendered perfect. The controller magnet is contained in a box (fig. 3) placed on the wall or other support near the generator, and consists of a delicate double axial magnet controlling the admission of current to the regulator upon the generator, and its action is exceedingly simple and effective. So perfect is the action that in a circuit of twenty-five to thirty lights, lamps may be removed or put out in rapid succession without apparently affecting those that remain. Even eight or ten lights may be instantly extinguished and the remainder burn as before.

It is unnecessary to speak of Thomson's arc lamp, spark preventer, distribution switch, &c., as the most novel of his inventions, and the most important, seems to be the machine. The features peculiar to this system are numerous, and we think that its introduction into England should be merely a matter of time.

ON THE ELECTRICAL TRANSPORT OF POWER.

By Dr. O. FRÖHLICH.

(*Concluded from page* 242.)

3. *Influence of the Wire Coils* (*see* fig. 9).

LET us suppose that a project for the transfer of power to a considerable distance has been elaborated, but the conduction proves too thick and too costly; a thinner wrapping is, therefore, to be tried, the number of the folds being doubled, but the section of the wires reduced by one-half: required what resistance must be given to the conduction without changing the working-power and the useful effect?

Let the original project be represented by the smaller figure; let the resistances of the machines = w, that of the conduction = l. When the section of the wire in a machine is reduced one-half, but the work remains the same, the electromotive force must be double as great, the strength of the current half as great, and the resistance of the machine four times as great. If this is to be the case with both machines, then, as may be geometrically deduced from the figure, the resistance of the circuit will increase fourfold. We have, then, for the second scheme the larger figure; in it the work and the useful effect are the same, but the resistance of the machine, w^1, and the resistance of conduction, l^1, are increased fourfold.

We see that in this manner any given resistance of conduction may be overcome without changing the working conditions, as has been practically shown by M. Deprez at Munich. We see also from the figure that if the revolutions remain the same, but the useful effect depends only on the proportion of the resistances of the machines and of the conduction, and therefore remains equal as long as this proportion is unchanged. If the resistance of conduction is null, the useful effect is the same for any kind of wire coils so long as the speed is unchanged.

In the experiment of Deprez at Munich the resistances of both machines were about equal to that of the conduction. The mechanical, useful effect was about 23 per cent., and the electrical 46 per cent.

In a group of experiments made by Siemens and Halske in the year 1880 (see *Electrotech. Zeit.*, 1881, p. 173), the same proportion held good; the resistance of both machines amounted to about 1 E, that of the conduction was the same; the mechanical useful effects obtained were from 27 to 34 per cent., and the electrical 34 to 56 per cent.

Between these experiments and that of Deprez there exists the same proportion concerning the useful effect as between the two figures, but with the difference, that the resistances in the experiment of Deprez were not merely four times, but 450 times greater than in the experiments of Siemens and Halske.

4. *Influence of the Resistance of the Conduction* (*see* fig. 10).

Let us suppose two machines of constant electromotive force (constant magnetism and constant speed), but with the resistance of the circuit variable. The figure shows that both the primary and the secondary working power

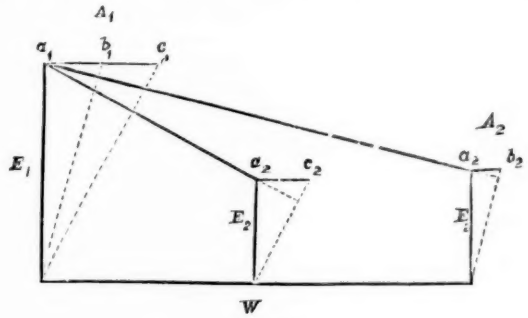


FIG. 10.

decreases as the resistance of the conduction increases; the useful effect remains the same, because the electromotive forces remain equal. Inversely it appears, as from figs. 7 and 8, that the same useful effect may be attained with any given resistance.

The greater the resistance the smaller the strength of current, and consequently the smaller the attractive power at the driving-wheel of the secondary machine.

A continually changing resistance occurs in practice only in the electric railway (*see* fig. 11.)

If the line is level the attractive force at the secondary machine is the same for the whole length of the line, *i.e.*, the strength of the current is constant. If we draw the line of tension with this strength of current, assuming the primary electromotive force as constant, and if we construct the work performed by the secondary machine at different points of the railway (a_2 b_2, a_2 b_2^1) it is plain that this work becomes smaller the greater the distance from the primary machine. If the line of tension is prolonged till it meets the axis of the abscissæ, and if we call the point of intersection the imaginary end of the railway, it is plain that the carriage performs work only till it has arrived at the

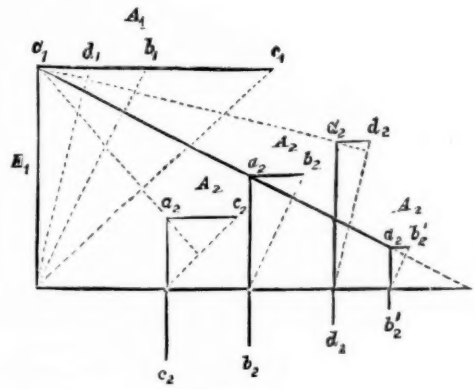


FIG. 11.

imaginary end. But the work is the product of attractive power and speed, and the attractive power is constant; the work, therefore, depends on and is proportional to the speed. Hence the speed of the carriages of an electrical railway is proportional to their distance from the imaginary terminal point.

If the railway is not level, but rises and falls in different parts, the attractive power is no longer everywhere constant, but greater or smaller by the components of the weight of the carriages parallel to the railway. If the curve of the attractive power for the secondary machine is known, the

strengths of the currents corresponding to the ascents and descents can be directly ascertained. By the strength of the current the inclination of the line of tension is given; we can therefore construct for any point of the railway the line of tension required and the work performed. By dividing the work of the attractive force we obtain the speed. In this manner plans may be drawn out showing the work and speed at any point of the line.

In fig. 11 $a_2 c_2$ represent the work at an ascent, $a_3 d_2$ that at a descent; the working powers are also shown below at the respective points on the axis of the abscissæ.

If we look back at the examples discussed, we can now reply to the question raised at the outset, whether there is a prospect of reaching with the machines as now constructed, the high, useful results which are theoretically possible.

If we suppose any two mutually suitable machines connected together for the transfer of power both at their maximum of strength of current and speed as calculated for permanent action (as has been already explained, the primary machine must be about double the size of the secondary).

This transfer produces in reality a mechanical useful effect of about 50 per cent. If in both the machines the mechanical friction and the currents in the iron core are reduced to a minimum, the useful effect will at the outside increase to 60 per cent. If a further increase is needed there remains only one expedient, an increase of speed; for the employment of thinner wire cannot, as we have seen, change the useful effect in the absence of any resistance of conduction.

With machines such as we have supposed, the speed cannot be increased, consequently larger machines must be used, which give the same electromotive forces and strengths of current at much lower speeds. The quantities of work and the electric useful effect are then the same as above, but the speeds may be increased and therewith not merely the working powers but the useful effect.

To obtain great useful effects it is requisite, therefore, to obviate the known losses of work and to employ relatively feeble currents and high speeds.

If it is required, on the other hand, to effect the greatest possible secondary work with given machines, both the speed and the current must be as great as possible.—*Electrotechnische Zeitschrift.*

"CONTRIBUTIONS TO THE CHEMISTRY OF STORAGE BATTERIES."*

By E. FRANKLAND, D.C.L., F.R.S.

1. *Chemical Reactions.*—The chemical changes occurring during the charging and discharging of storage batteries have been the subject of considerable difference of opinion amongst chemists and physicists. Some writers believe that much of the storage effect depends upon the occlusion of oxygen and hydrogen gases by the positive and negative plates or by the active material thereon, some contend that lead sulphate plays an important part, whilst others assert that no chemical change of this sulphate occurs either in the charging or discharging of the plates.

To test the first of these opinions, I made two plates of strips of thin lead twisted into corkscrew form, and after filling the gutter of the screw with minium, so as to form a cylinder that could be afterwards introduced into a piece of combustion-tubing, these plates were immersed in dilute sulphuric acid and charged by the dynamo-current in the usual manner. The charging was continued until the whole of the minium on the + and — plates respectively was converted into lead peroxide and spongy lead, and until gas bubbles streamed from the pores of the two cylinders.

After removal from the acid the plates were superficially dried by filter-paper, and immediately introduced into separate pieces of combustion-tubing previously drawn out at one end, so as to form gas delivery tubes. The wide ends of these tubes were then sealed before the blow-pipe, care being taken not to allow the heat to reach the enclosed cylinders. The tube containing the cylinder of reduced lead was now gradually heated until the lead melted, the drawn-out end of the tube meanwhile dipping into a pneumatic trough. The gas expelled from the tube consisted almost exclusively of the expanded air of the tube and contained mere traces of hydrogen.

The tube containing the cylinder of lead peroxide was similarly treated, except that the heat was not carried high enough to decompose the peroxide. Mere traces, if any, of occluded oxygen were evolved.

These results justify the conclusion that occluded gases play, practically, no part in the phenomena of the storage cell.

With regard to the function of lead sulphate in storage batteries, I have observed that during the so-called "formation" of a storage cell, a very large amount of sulphuric acid disappears from the liquid contents of the cell: indeed, sometimes the whole of it is withdrawn. The acid so removed must be employed in the formation of insoluble lead sulphate upon the plates, which, in fact, soon become coated with a white deposit of the salt, formed equally upon both positive and negative surfaces. This visible deposit is, however, very superficial, and does not account for more than a very small fraction of the acid which actually disappears from solution. The great bulk of the lead sulphate cannot be discovered by the eye, owing to its admixture with chocolate-coloured lead peroxide.

Unless the coated plates have been previously immersed for several days in dilute sulphuric acid, this disappearance of acid during their "formation" continues for ten or twelve days. At length, however, as the charging goes on, the strength of the acid ceases to diminish and soon afterwards begins to augument. The increase continues until the maximum charge has been reached and abundance of oxygen and hydrogen gases begin to be discharged from the plates; that is to say, until the current is occupied exclusively, or nearly so, in the electrolysis of hexabasic sulphuric acid expressed by Burgoin in the following equation:—

$$\underset{\text{Sulphuric acid.}}{SO_6H_6} = \overbrace{\underset{\text{Sulphuric anhydride.}}{SO_3} + 3O}^{\text{Eliminated on + plate.}} + \overset{\text{Eliminated on — plate.}}{3H_2}.$$

Of course the sulphuric anhydride immediately combines with water and regenerates hexabasic sulphuric acid:—

$$SO_3 + 3OH_2 = SO_6H_6.$$

On discharging the cell, the specific gravity of the acid continually decreases until the discharge is finished, when it is found to have sunk to about the same point from which it began to increase during the charging. Hence it is evident that, during the discharge, the lead sulphate, which was continuously decomposed in charging, was continuously reformed in discharging.

The chief, if not the only chemical changes occurring during the charging of a storage battery, therefore, appear to be the following:—

1st. The electrolysis of hexabasic sulphuric acid according to the equation already given.

2nd. The reconversion of sulphuric anhydride into sulphuric acid.

3rd. The chemical action on the coating of the + plate.

$$\underset{\text{Lead sulphate.}}{SO_4Pb} + O + 3OH_2 = \underset{\text{Lead peroxide.}}{PbO_2} + \underset{\text{Hexabasic sulphuric acid.}}{SO_6H_6}$$

4th. The chemical action on the coating of the negative plate:—

$$\underset{\text{Lead sulphate.}}{SO_4Pb} + H_2 + 2OH_2 = Pb + \underset{\text{Hexabasic sulphuric acid.}}{SO_6H_6}.$$

If I have correctly described these changes, the initial action in the charging of a storage cell is the electrolysis of hexabasic sulphuric acid, each molecule of which throws upon the positive plate three atoms of oxygen, and upon the negative plate six atoms or three molecules of hydrogen. Each atom of oxygen decomposes one molecule of lead sulphate on the positive plate, producing one molecule of lead peroxide, and one of sulphuric anhydride, the latter instantly uniting with three molecules of water to form hexabasic sulphuric acid.

* Read before the Royal Society. Received February 21st, 1883.

The following are the chemical changes which I conceive to occur during the discharge of a storage cell :—

1st. The electrolysis of hexabasic sulphuric acid as in charging.

2nd. The reconversion of sulphuric anhydride into hexabasic sulphuric acid as already described.

3rd. The chemical action upon the coating of what was before the positive plate or electrode, but which now becomes the negative plate of the cell—that is to say, the plate from which the positive current issues to the external circuit :—

$$\underset{\text{Lead peroxide.}}{PbO_2} + H_2 = \underset{\text{Lead oxide.}}{PbO} + \underset{\text{Water.}}{OH_2}.$$

The lead oxide thus formed is immediately converted into lead sulphate :—

$$PbO + SO_6H_6 = SO_4Pb + 3OH_2.$$

4th. The chemical action upon the coating of what has now become the positive plate of the cell :—

$$Pb + O + SO_6H_6 = SO_4Pb + 3OH_2.$$

Thus in discharging, as in charging, a storage cell, the initial action is the electrolysis of hexabasic sulphuric acid. The oxygen eliminated on the positive plate reconverts the reduced metal of that plate into lead oxide, whilst the hydrogen transforms the lead peroxide on the negative plate into the same oxide, which in both cases is immediately converted into lead sulphate by the surrounding sulphuric acid, thus restoring both plates to their original condition before the charging began.

The real "formation" of the cell consists, I conceive, in the more or less thorough decomposition of those portions of the lead sulphate which are comparatively remote from the conducting metallic nucleus of the plate. Lead sulphate itself has a very low conductivity, whilst lead peroxide, and especially spongy lead, offer comparatively little resistance to the current, which is thus enabled to bring the outlying portions of the coating under its influence. It may be objected that, during the discharge, the work of formation would be undone ; but, probably, in the ordinary use of a storage battery, the discharge is never completed. Thus I have found that, in a small cell containing two plates, 6″ × 2″, short-circuiting with a thick copper wire for twelve hours was far from producing complete discharge, for on breaking this short-circuit, the cell *instantly* rang violently an electric bell with which it was previously connected. In ordinary discharges of "formed" cells, therefore, the lead sulphate on the positive and negative plates still remains mixed with sufficient lead oxide and spongy lead respectively to give it a higher conducting power than the sulphate alone possesses.

2. *Chemical Estimation of the Charge in a Storage Cell.*—No method has hitherto been known by which the charge in a storage cell could be ascertained without discharging the cell ; but the results of the foregoing experiments indicate a very simple means of ascertaining the amount of stored energy without any interference with the charge itself. The specific gravity and consequent strength of the dilute sulphuric acid of a "formed" cell being known in its uncharged and also in its fully charged condition, it is only necessary to take the specific gravity of the acid at any time in order to ascertain the proportion of its full charge which the cell contains at that moment ; and if the duty of the cell is known, the amount of energy stored will also be thereby indicated. In the case of the cell with which I have experimented, containing about seven quarts of dilute sulphuric acid, each increase of ·005 in the specific gravity of the dilute acid means a storage of energy equal to 20 ampères of current for one hour, obtainable on discharge.

I hope shortly to be able to express, in terms of current from the cell, the definite relation between the amount of energy stored and the weight of sulphuric acid liberated.

Underground Wires in New York.—The Bill compelling all telegraph, telephone, and electric light wires to be placed underground has been passed by the State Senate of New York to its third reading.

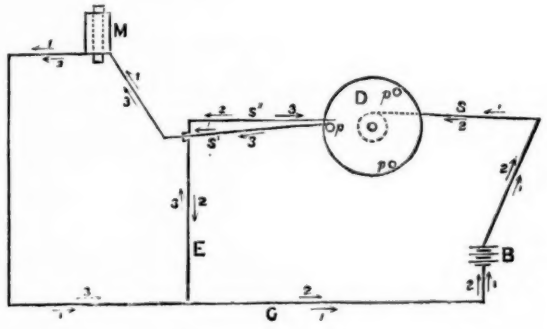
A SPARKLESS CURRENT-BREAKER.*

By LOUIS H. SPELLIER.

THE fact that the spark of the induced current of electro-magnetic instruments will destroy the contact surfaces by which the making and breaking of the circuit is effected, is very keenly felt on current-breakers for electro-magnetic time telegraphs.

A device for the purpose of obviating the spark, invented by Dr. Hipp, has been in use successfully for some years at Geneva, to distribute astronomical time through the different sections of that city.

The writer presents in the accompanying diagram a



device of his own for the same purpose, which, he believes, will commend itself for simplicity as well as for effectiveness.

The metal disc, D, is fastened to the axle of the escape-wheel of a clock, and has as many platinum pins, *p*, attached vertically upon its face as there are openings and closings of the circuit needed during the time it completes one revolution. *d* is a platinum disc fastened to the pin-bearing disc ; S and S′ are two contact springs. The spring, S, rests upon the platinum disc, while S′ is to make the contact with the pins, *p*. When the disc moves with the escape-wheel of the clock, and the spring, S′, comes in contact with one of the pins, *p*, the circuit of the battery is completed and broken when removed from it.

In the diagram, D represents the current-breaker ; B the battery ; M the electro-magnet ; and F the ground conductor. The spring, S′, is in contact with a pin and thereby completes the circuit. The current now takes the course as shown by the arrows, 1. The contact spring, S″, is placed a little higher than S′, and therefore does not yet touch the pin, *p*. But as soon as D moves on again, S″ will, a moment before S′ leaves the pin, come also in contact with it ; at this moment S″ will make a short-circuit through the conductor, E, and the course of the battery current becomes that of the arrows, 2, while the induced current of M, at the moment the short-circuit is made, takes the course as indicated by the arrows, 3. A moment after S′ leaves *p*, S″ follows it, and the short-circuit of the battery is also broken.

Telegraphic Memorials.—The Press Association states that Mr. Monk, M.P., President of the Associated Chambers of Commerce, has forwarded memorials to the Postmaster-General, urging a reduction in the charges for the use of telephones. In consequence of the frequent interruptions to telegraphic communication by storms, Government is also asked to take steps to have the principal lines of wire conveyed underground. It is further urged that the time has come for the concession by the Post-office Department of a lower rate for short inland telegrams. The Government is requested to enter into negotiations with foreign countries for the purpose of cheapening and facilitating telegraphic communication.

* "Journal of the Franklin Institute." With the exception of an additional contact spring, S″, the current-breaker is the same as described in the "Journal of the Franklin Institute," August number, 1882.

TELEGRAPHS OF THE ANCIENTS.

From the Fall of Troy to the Battle of Waterloo.

On Wednesday evening, the 14th inst., Mr. Alderman W. H. Bailey delivered a most interesting lecture on the above subject at the Museum and Art Gallery, Peel Park, Salford, Mr. Alderman Bowes in the chair.

After a few opening remarks by the chairman, Mr. Bailey then delivered his lecture, from which we make the following extracts, which will doubtless be appreciated by the general reader.

American and African Sign Language.

We are told by Lubbock and other writers of the history of civilisation, that many savage tribes, by reason of their poverty of word language, are compelled to carry on a conversation by signs. Some have thought that certain of these tribes are entirely without language, but this seems extremely improbable. The statement may have arisen from the fact that in all countries inhabited by savages the number of languages is very great, and hence there is a great advantage in being able to communicate by signs. James, the American traveller in the Rocky Mountains, mentions that several tribes under the influence of one great chieftain, were totally ignorant of each other's voice language, insomuch as it was no uncommon occurrence to see two men of different nations sitting upon the ground and conversing freely by means of the language of signs. Fisher, another traveller among the American Indians, mentions a language of signs, however, by which all nations and traders can understand one another, and they always make these signs when communicating among themselves. The men, when thus talking together, sit cross-legged like Turks, and communicate with each other with a speed and with a definiteness which would even be understood by a deaf man. For instance, Fisher says, "I meet an Indian, and wish to ask him if he had seen six wagons, drawn by horned cattle, with three Mexican and three American teamsters, and a man mounted on horseback. I make these signs:—I point 'you,' then to his eyes, meaning 'see,' then hold up all my fingers on the right hand and the fore-finger on the left, meaning 'six'; then I make two circles by bringing the ends of my thumbs and fore-fingers together, and, holding my two hands out, move my wrist in such a way as to indicate waggon wheels revolving, meaning 'waggons.' Then by making an upward motion with each hand from both sides of my head I indicate horns, signifying 'horned cattle.' Then by first holding up three fingers and extending my right hand below my lower lip and moving it downwards, stopping it midway down the chest, I indicate 'beard,' signifying 'Mexican.' And in this way, and by other similar signs and motions, I ask the Indian, 'You see six waggons, horned cattle, three Mexicans, three Americans, one man on horseback?' If he holds up his forefinger and lowers it quickly, as if he were pointing it at some object on the ground, he means 'Yes'; if he moves it from side to side, on the principle that people sometimes move their head from side to side, he means 'No.'" Fisher says it takes about the same time to make these signs that it would take to ask the question verbally. The bushmen of South Africa, we are informed by another traveller, intersperse their language with so many signs that they are perfectly unintelligible in the dark; and when they want to converse at night they are compelled to gather round their camp fires. The celebrated traveller, Burton, says of a tribe of North American Indians, who possess so scanty a vocabulary that they cannot talk in the dark, that to make a stranger understand them they must always repair to the camp fire for a "powwow."

Telegraphs before the Christian Era.

For purposes of war and defence, methods of communicating from distant places have been used in all historic times varying very little in character, and distinguished more or less by ingenuity. Bells, torches, flags, and symbols have been used for purposes of communication from the earliest known periods. The Egyptians had signals to indicate the rank of important officers of state, many of which signals have been discovered in the excavations amongst the ruins of their great temples and monuments, and in the carving upon their sculptures. Among the Greeks, the Athenians had an owl and the Thebans a spinx upon their banners and standards. And we are told that by using these emblems and signs in a manner understood by the various companies of soldiers in war, the standard-bearers were enabled to telegraph such orders as "advance" and "retreat," and to control other important military manœuvres. The use of these emblems in indicating the position of companies and regiments, in guiding friends and warning foes, was of as much advantage to the soldiers of the old days as the numbering of the houses in the streets is to us in these later times. Indeed, this use of emblems, not only among the ancient Greeks and Romans, and even the Egytians, but down to our own days, has given rise to the art or science of heraldry. In this way were the barons and knights of old, as well as the commanders of famous legions, enabled to emblazon various devices on their coats of arms, many of which we still see displayed by those who are proud of their family blood, and of what stock they claim to belong to. On some occasions the device would be carefully prepared and thought out; in other cases the symbol would be something at hand which had been seized in an emergency and lifted up as a rallying point for the people, and afterwards adopted from the attachment which clung to it as an object identified with patriotic deeds. One of this sort must have been the Persian blacksmith's apron, which, for many years until the Mohammedan conquest, was the standard around which the people rallied to resist the invader. As I have indicated, these banners and emblems were used not only to gather the troops together, but as telegraphs, to communicate the plan of operation in warfare. Fires by night and pillars of smoke by day, seem to have been used both by most civilised and savage peoples in all ages, for transmitting messages. Various Roman writers mention different methods of communicating by means of torches. Julius Africanus says, "substances were made use of in making the torch fires"; and some writers have thought that these fires and torches may have been of different colours, thus enabling the Roman generals to ring the changes in spelling words and in sending messages.

Alphabetical Telegraph of the Greeks.

Probably one of the most ingenious telegraphs of ancient times was one used by the Greeks. The Greeks had a very good method of indicating the time of day by a clepsydra, or water clock. Indeed, the idea was the same as in the old-fashioned hour-glass; only instead of sand being used, observations were made by the fluctuations of the water. I will now endeavour to describe one of these clocks, a model of which we have on the table here. You will be kind enough to imagine two of these water clocks, which have been regulated for the floats to descend at exactly the same speed. They have been made, to use a scientific term, synchronous—that is, made to keep equal time. We will imagine one of these instruments placed at night, with the sender of a message, on the top of a mountain, and another on a distant hill, say two miles away. There we have them, sender and receiver. When a message had to be sent, the sender would hold his torch up. That was the signal for the receiver to prepare his instrument, and set it to zero by filling up with water. The sender would hold up his torch twice. This was a signal that he had permitted his clock to start running down; that is to say, for the water to escape by means of a faucit at the bottom. The receiver, seeing this signal would at once allow his water clock to begin running down, and so both clocks would go on doing this at the same speed. Then, when the sender held up his torch again, it was a signal to stop. The receiver would stop his instrument and look on the stem for the letter of the alphabet which the sender meant to indicate. And thus, by repeating the operation the needful number of times, a message could be spelt out with great facility. It is very remarkable that this ingenious water clock telegraph of the ancients, with a slight modification which I will explain later on, was similar to one of the first alphabetical telegraphs in this country, introduced by Mr. (afterwards Sir) Francis Ronalds, about the time of the battle of Waterloo. Instead of using water clocks, Mr. Ronalds permitted two clocks, with weights and wheels, to run down, having, indeed, in his mind exactly the idea which the old Greeks had over 2,000 years ago.

Flash-light Telegraph.

A new departure in torch telegraphy was made in the Shetland Isles, at the beginning of this century, by the Rev. James Bremner, to whom the Scottish Society of Arts presented its medal for his invention. By the use of a single torch the rev. gentleman was enabled to send messages. This was done by alternately exhibiting and concealing one torch. Indeed, so far as I have been able to learn, Mr. Bremner may be considered to be the inventor of the flash-light system, which, in a modified form, is now used on the vessels of the British navy, and also by our army in the field at night. It was used in the recent campaigns in Abyssinia, Afghanistan, and Egypt. This alternate exhibition and concealment of the light enables a word to be sent nearly as fast as a man can write. No doubt most of you are aware that a flash-light telegraph is made by a piece of "looking-glass," and used when the sun shines. This is called the heliograph. Messages are sent by simply placing this looking-glass at such an angle as to reflect the sun's rays. By means of a telescope messages have been received in this way from a station ten miles away. The Morse code of the dot and dash system is used for the flash-light purposes; and by alternately exposing and concealing the looking-glass by day and the lantern by night messages can be sent, as I have said, nearly as fast as a man can write. It seems that Mr. Bremner, the Shetland clergyman, put his plan into operation, and was enabled to communicate at night between one island and another; and he established two stations, one in Scotland and the other in Ireland, and was thus in a position to telegraph between points twenty miles apart.

Washington's Telegraph.

During the American revolutionary war, or war of independence, as it is called, many methods of signalling the approach of the enemy were used. Among the various plans was one of which this model on the table is an illustration. This telegraph consisted of a post or mast which was portable, a tub or barrel placed on the top, a movable flag on one side, and a basket on a bracket near the top, were used to signal with. By ringing the changes with the flag, the basket, and the barrel, and by moving the flag up and down, various signals could be sent. Altogether, I believe that 50 different signals could be given by this means.

Semaphore Telegraphs.

We now come to the semaphore signals, which are used even to the present day, chiefly for railway purposes. Probably the most ingenious and among the first of this class of telegraphs was that invented by the brothers Chappé. It appears that this invention is due to the affection entertained by the two brothers for each other. They were placed as students at different schools, a mile and a half apart. They were inconsolable at being thus separated, and, by means of pieces of wood exposed from the back windows of each school, the brothers Chappé contrived to talk to each other. In their first system of telegraphing they arranged a code of signals which enabled them to send 192 different messages, this being done by means of instruments similar to the one I now have on the table. As the ingenious brothers became older, the invention was

placed before the government, and was tried just before the revolution in 1791. The people, however, looked upon the invention as only another means of increasing the power of the government and the aristocracy. The introduction of the invention was opposed: the people destroyed the telegraph stations, and the inventors barely escaped with their lives. A second attempt shared the same fate. Again the various telegraph stations were burned to the ground. The brothers Chappé, however, continued their efforts, and in 1793 the government adopted the system. Circumstances were favourable. The telegraph, having been adopted, was fortunate enough to communicate to Paris the news of a great French victory; and now the brothers Chappé were considered part and parcel of the glories of France. This message was transmitted from the frontier to Paris: "Condé is taken from the enemy," to which the Directory replied: "The army of the north deserves the gratitude of the country." These messages ran like an electric shock throughout the convention and throughout Paris. The once-abused telegraph was now the pride of the nation, and its inventors were worshipped as public benefactors. The system invented by the brothers Chappé soon became universal on the continent. A line was carried from Paris to Lille, and two minutes only were occupied in transmitting a word. In 1802, the system was adopted in Denmark. Shortly afterwards it was made use of by the governments of Belgium, Sweden, and Germany. Mahomet Ali erected stations on this system from Alexandria to Cairo. The most expensive series of stations was constructed in Russia, by the Emperor Nicholas. A line of towers was erected from the German frontier, through Warsaw, to St. Petersburgh. This line embraced 220 stations, at each of which were six men, so that 1,320 men were employed on this route, beside those who had charge of the general administration. The erection of these towers cost the Russian Empire millions of pounds sterling. The system was only finished and got to work so comparatively recently as the year 1858; and, after being in operation but a very short period, it was completely superseded by the electric telegraph. The towers are still standing, silent monuments to the ingenuity of the past. Scarcely any description is required of this Chappé semaphore telegraph. The method of manipulating the arms was by means of levers, similar to those now in daily use on our own railways. Occasionally the system was used at night by placing lanterns on the ends of the vanes. Men were stationed along the line of communication with telescopes. And thus by means of known changes, various codes could be worked at great speed. In France, along the route between Toulon and Paris, a distance of 475 miles, there were 120 stations; and it is said that so complete were the instruments made that over 82,000 different signals could be sent. The Prussian system of semaphore signals, a model of which we have on the table, was introduced in the year 1782. It will be seen that this is but a modification of the French system.

ENGLISH SEMAPHORES.

Forty thousand signals could be sent by this means. The English semaphore shutters, or Louvre telegraphs, were invented by Lord Murray in 1795. The instrument, as you see here, consists of six shutters working on pivots. Sixty-four distinct signals could be sent by this system from London to Dover in ten minutes. These were placed along the coast, leading to stations inland, and were in general use in this country up to the invention of the electric telegraph. Messages could only be sent in the day time by this system. It is mentioned that after one of Wellington's victories over the French, when the news was being sent to London, the sender at the coast end began the signal with the words "Wellington defeated ——." A dense fog prevented the rest of the message being seen, and the result was great consternation in London and a panic on the Stock Exchange. When the fog cleared up the following day, the rest of the message was received, and the message then read—"Wellington defeated the French." I remember when I was a boy, this system being used between Holyhead and Liverpool, for sending news of the arrival of the American mail. On the vessel being sighted at Holyhead, the news was sent forward right across Anglesey to Puffin Island; thence to the Great Orme's Head, thence right along the Welsh coast to Parkgate; across the mouth of the river Dee, and thence to Liverpool. For many years the intelligence sent in this old-fashioned way from Holyhead to Liverpool, was sent from Liverpool to Manchester by electric telegraph. Many of the old stations on the line of route between Holyhead and Liverpool are still in existence, though their occupation has gone.

THE RONALDS ELECTRIC TELEGRAPH.

The model on the table here is one of the system invented by Sir Francis Ronalds. There are many points of similarity between it and the Greek water clock telegraph. Sir Francis recommended the use of clocks with wheels, one at the sending and the other at the receiving station. These clocks were made to drive dials at exactly the same speed—to work isochronously. The alphabet, as you see, is painted on the dials which revolve behind a little hole, showing one letter at a time. The sending and receiving instruments are coupled together by means of an electric wire. Pith ball electrometers are hung in the front of each dial. On the balls being extended by means of an electric current, this signal would cause the receiver to allow the clock to run down. Another signal causes the clock to be stopped. The sender and the receiver, starting and stopping the clocks in this way, were enabled to send and receive messages in a comparatively quick manner. This, although not the first electric telegraph, is one of the first invented that was of a workable character. The inventor communicated his ideas to the War Office soon after the battle of Waterloo, and he received an intimation from the authorities there to this effect:—"Now that the war is over, telegraphs will be no longer required." (Laughter.) The telegraphs I have endeavoured to describe are chiefly those used for the purposes of war. Even in this country it was considered by official persons that the arts of peace would not be much benefited by those quick methods of communication. It is not within the scope of the lecture this evening, nor have we time, to consider modern telegraphy. For the present I may be permitted to say that, according to Mr. W. H. Preece, 400 words per minute can now be telegraphed along one wire, as a result of the recent improvements of duplex and quadruplex circuits in connection with automatic instruments. When the telegraph service was taken over by the Government a few years ago, 126,000 messages were sent per week. Now, the weekly number is over 600,000. In press work the increase is most marked; the rate in this period having risen from 5,000 words per day to nearly 1,000,000—that is to say, 340,000,000 words of press messages having been delivered during last year. England has not a monopoly of this useful agent. All prominent countries exhibit corresponding growth. The Japanese even dispatch 200,000,000 messages a year. The telephone is another wonderful advance in telegraphy. To enable people to speak in actual words, with the accent and exact tone, to their friends miles away, is a splendid scientific triumph. The electric telegraph is one of the great mutually dependent blessings of these modern days. It is powerful in promoting the uses of civil life, it is blessed in strengthening the arts of peace.

ELECTRIC LIGHT LEADS.

THE limit of 2,000 ampères per square inch sectional area of pure copper, as suggested in the Draft Provisional Orders which were submitted by several electric light companies to the Board of Trade, was pronounced by us in a leading article of February 24th, to be "rather unsafe." The same opinion seems to have been generally adopted, although the expression is scarcely a correct one. The proposed limit might not be, strictly speaking, unsafe, but it would not be *economical*. The temperature of a lead of circular section one square inch area traversed by a current of 2,000 ampères, would, if of bright copper, be raised, as we observed, to nearly that of boiling water. There would, however, be no more want of safety in such a lead, in so far as either personal danger or fire-risk is concerned, than there would be through the coffee-pot on our breakfast table. A wire properly covered with india-rubber, with a good radiating surface, would of course take a much lower temperature. What temperature the insulating material might safely bear without injury is another matter, and would depend upon the material itself. As regards distributing mains such a temperature is never likely to be approached, at least by any company who possesses an engineer who is in his right senses. The object of the Board of Trade in fixing a limit to the current strength to be employed in any given section of lead, is probably to guard against the dangerous effects of possible ignorance or carelessness on the part of both undertakers and consumers. As far as the undertakers are concerned, their interest lies so obviously, within certain limits, in employing an excess of copper rather than a deficiency, that they might be safely trusted to employ a size of lead greatly in excess of anything which the Board of Trade would be justified from its point of view in requiring. The reason of this is that the H. P. wasted in the lead increases so much more rapidly with diminished sections than the temperature does, that the latter consideration practically disappears, and the problem becomes, not what is a safe lead in point of temperature, but what is an economical lead in point of wasted H. P.

The following figures will make our meaning clear, and although our correspondent, "E," rather forestalled us last week, we venture to insert the figures we had arrived at as an addition to his valuable letter. Assume that a current of 500 ampères has to traverse a distributing main, and we wish to compare the yearly cost of wasted H. P. in the copper with the yearly interest, &c., on the first cost of the main itself.

Area of copper conductor.	Approximate elevation of temperature of conductor uncovered.	H.P. expended in 1 mile of conductor.	Yearly cost of H.P. expended in 1 mile of conductor.	First cost of 1 mile of lead approx.	Interest on and depreciation of lead =20 per cent. of cost.	Cost of H.P. expended on, plus interest and depreciation of lead.
sq. in.	dg. Fah.		£	£	£	£
0·4	61	32	640	900	180	820
0·5	45	26	520	1100	220	740
0·6	35	21	420	1300	260	680
0·7	27	18	360	1500	300	660
0·8	22	16	320	1700	340	660
0·9	19	14	280	1900	380	660
1·0	16	13	260	2100	420	680
1·1	14	12	240	2300	460	700
1·2	11	11	220	2500	500	722

These figures are, of course, only approximate, but near enough for illustration. Suppose we are allowed to employ a lead carrying 1,000 a. per sq. inch, and that we take a section of 0·5 sq. inch for the 500 a., we find that in each mile we waste 26 H. P. Now, 1 H. P. electrically accounted for costs at the very lowest estimate, during 365 days, at 24 hours per day, £20 per year; 26 H. P. therefore costs 26 × 20 = £520 per year wasted; whereas the lead in first place costs less than double that sum. It will therefore pay best to employ two such leads, or a total of 1 sq. inch section of copper. The H. P. wasted now would be reduced to half the amount, or £260 per annum, while interest and depreciation in the lead, placed at a very high figure, would be £420 per year, so that in saving £240 per annum in wasted H. P., we have expended an extra capital represented by a yearly interest, &c., of £220. That is practically about the same value, but with this difference, that whereas the money expended in the H. P. would be absolutely wasted, that expended in the copper constituent of the lead, that is, nearly half its value, is recoverable. Therefore, although the Board of Trade may, and no doubt will allow us, to send 1,000 ampères through an inch square of copper, self-interest will show the undertakers that 500 ampères through that section will be a more profitable limit from a pecuniary point of view. There is, of course, a limit to this, and when due allowance is made for recoverable copper, if the interest and depreciation are equal to the amount calculated to be wasted in H. P. in the lead, then any further increase in the copper would be attended with loss. Indeed, it naturally follows that from the point of balance of these two items, either increase or any decrease is attended with loss. Now, the balance in question happens to require a rather large expenditure in copper, much larger, in fact, than the Board of Trade would be justified in requiring; because the question involved is not one of personal danger or fire-risk through increased temperature, but one of economy in working, that is to say, it is not a public question but one for whoever is responsible for the financial part of the undertaker's business. It is therefore something in the nature of wasted time to discuss what would or would not be a safe current to employ, because such a limit as is likely to be allowed and which would be perfectly safe would mean simply a constant, heavy, and unnecessary outlay by the undertakers if it were literally taken advantage of.

THE SCHOOL OF TELEGRAPHY AND ELECTRICAL ENGINEERING.

SINCE this school was first established several years ago, the progress which electrical science has made has necessitated a very considerable increase in its educational resources in order that it may be able to keep pace with the times. The proprietors and managers of the establishment, which we had recently the opportunity of visiting, have evidently been quite impressed with the necessity of not being behindhand, for they have at the present time in use for purposes of instruction a collection of electrical and telegraphic apparatus and appliances of a very complete character. It would be difficult, indeed, to name any establishment which possesses such complete means of imparting instruction in electrical engineering generally, but more especially in submarine telegraphy, whilst the fact that the school has now been in existence for a number of years points to the conclusion that its value is appreciated.

Although theory is by no means neglected, the general instruction is of a very practical nature. As regards submarine telegraphy, a commodious hall is provided which contains every description of instrument employed in such work; in fact, it can be seen that no expense has been spared in making the fittings as complete as possible. Galvanometers, electrometers, resistance-coils, condensers, &c., sufficient to enable a large number of students to work without interfering with one another, are arranged round the room and on tables, whilst a special feature consists in an artificial cable, equal to a line considerably longer than an Atlantic cable. This cable can be split up into short sections, so as to represent a circuit of any required length. The methods of localising faults are explained and practical instruction given in the same. The students have also opportunities of detecting and remedying defects which frequently occur in testing apparatus, and which often require considerable skill and patience to remove. Signalling on the various forms of instruments in general use is thoroughly taught, and great care is taken that code signalling on the mirror instrument is well learnt. Correctness in such signalling is important, and accordingly numerous "catch" words are included on the message forms (representing actual messages), so that the learner's efficiency is thoroughly tested. In connection with submarine telegraphy, the making of joints in gutta-percha core is practically exemplified.

The arrangement of telephone exchanges is shown by means of the various instruments now generally used, and also by means of switch boards, so that a student who thoroughly masters the subject is competent to fit up such apparatus for practical working.

For instruction in electric light engineering, a gas-engine and several forms of dynamo machines are provided, together with different kinds of lamps, so that the student has the opportunity of studying the adjustments, &c., of the various parts. All the necessary instruments for taking electromotive force, resistance, current, &c., measurements by various methods are also provided and kept joined up ready for practice in making the tests. The construction of secondary batteries is also gone into, and in this department some original work is being carried out.

Theoretical instruction, both elementary and advanced, is carried out by the aid of classes, at which the construction of apparatus and the laws governing its use is explained, the lectures being illustrated by apparatus, diagrams, &c. Altogether the general course of instruction pursued is very complete, whilst the opportunities afforded for obtaining practical information are considerable.

BALL'S "UNIPOLAR" DYNAMO-ELECTRIC MACHINE.

IN the ELECTRICAL REVIEW for July 22nd, 1882, will be found in our "Notes" columns a small sketch of the machine which we now illustrate more fully and describe in detail. The apparatus has been brought over to London by Mr. C. W. Raymond, to whose courtesy we are much indebted for information concerning this invention. The patentee is Mr. Charles Ball, of Philadelphia, U.S.A. The machine is at present to be seen at 40 and 41, Kirby Street, Hatton Garden, E.C., where it has been in action for some weeks past. Before saying more, we will give an extract from the inventor's specification (No. 84, 1882):—

"Heretofore, dynamo-electric machines have been so constructed that the armature revolved in the field, or within the inductive influence, of two or more poles of a magnet or magnets. The communicator of this invention has discovered, that by employing only one pole of the field-magnet, or what amounts to the same thing, arranging the armature to rotate within the inductive influence of only one pole of the field-magnet, vastly improved results can be obtained—that is, that greater quantity and increased intensity of current are secured, while at the same time the armature will require very much less power to effect its rotation than would be necessary if rotated in the field of two or more poles.

"Hence this invention consists partly in the arrangement, in a dynamo-electric machine, of an armature rotating in the field of only one pole of a magnet.

"The said communicator has further discovered that by constructing a dynamo-electric machine with two armatures each of which revolves within the inductive influence of only one pole of a magnet, and connecting the magnet and armature helices in one circuit, the quantity and intensity of current generated will be vastly increased.

"The said invention, therefore, further consists partly in the combination, in a dynamo-electric machine, of two or more armatures, each arranged to rotate in the inductive field of only one pole of an electro-magnet, both of said armatures and the magnet being in the same circuit.

"In carrying the said invention into practice I provide a

frame consisting of an iron base with two uprights or end pieces of the same material securely bolted to said base. There are two parallel bars of soft iron sustained by their ends in the uprights. These bars constitute the cores of the electro-magnets composing the field. Each of these bars is wound with wire to form helices. Tothe inside of each bar is fastened an iron pole-piece ; two shafts are arranged in the same line, but independent of each other, each having a

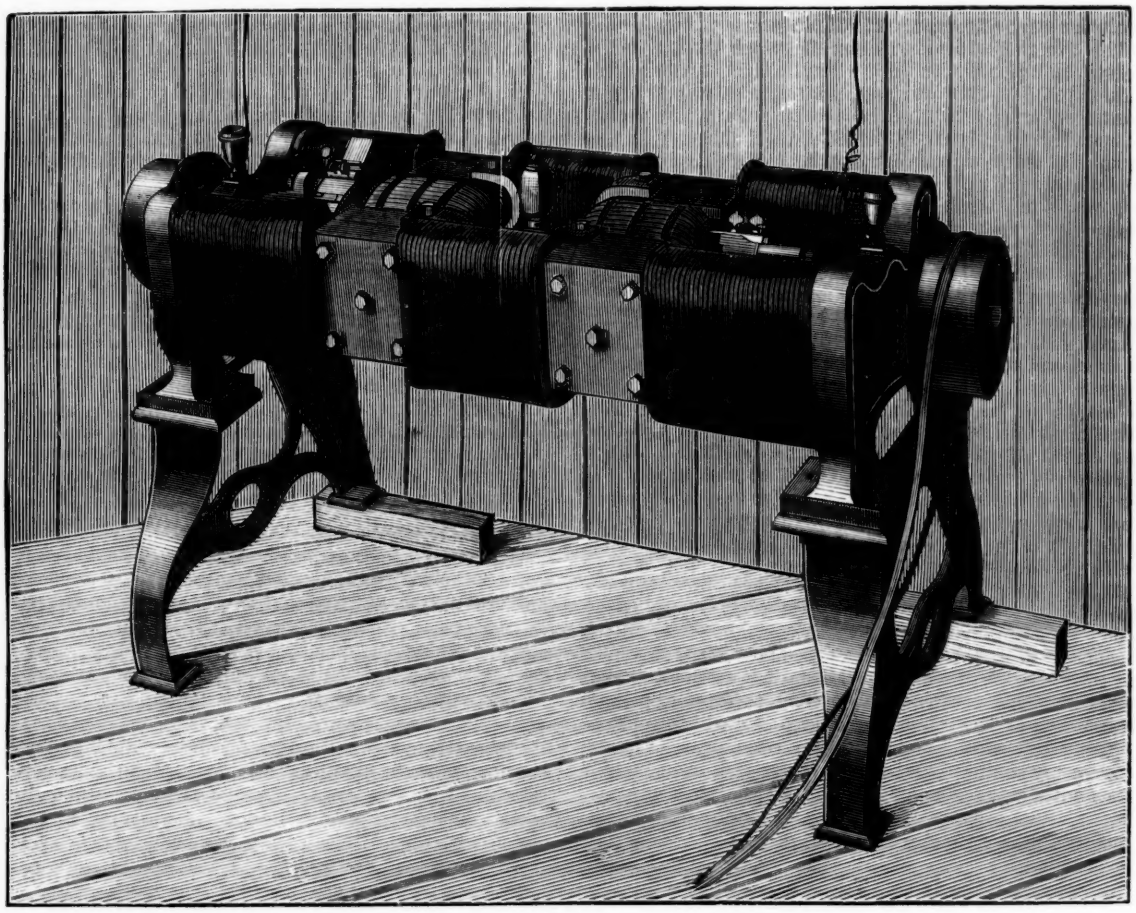


FIG. 1.

pulley whereby said shafts, and the armatures which they carry, can be rotated in opposite directions—*i.e.*, one shaft in one direction and the other shaft in the contrary direction.

"I provide armatures of any ordinary or suitable construction carried on the shafts and located within the inductive influence of the poles—*i.e.*, one armature is in the field of one pole and the other armature in the field of another pole. I also provide suitable commutators. The connections established in one manner with unlike poles make the derived currents all of the same direction in the external circuit. By altering the connections the poles may be rendered alike, and the current still preserved of like direction. Hence my invention is not limited to an arrangement involving unlike poles ; but when the poles are alike the armatures should revolve in the same direction, in which case they may be mounted on one shaft or on independent shafts.

"By locating the armatures, however, on independent shafts and connecting the same with the field, the armatures mutually assist the rotation of each other. As soon as the power-driven shaft acquires speed and generates a current, such current, passing into the field, magnetises the pole-piece of the armature on the other shaft, and by induction produces a rapid rotation of such other armature and shaft. When power is applied to both shafts the armatures mutually assist each other in like manner, the result being that the machine may be driven by relatively very much less power than is required for any other known dynamo-electric machine capable of generating the same amount of electricity."

Without any criticism in the present article on Mr. Ball's ideas, we will at once proceed to place before our readers the particulars of a machine which is quite unlike any other in construction. The general view of the dynamo is shown in fig. 1, and fig. 2 is a diagrammatic sketch of the parts, showing also the connections as now existing. It must be understood that more recent forms of this machine are somewhat different in design, as we shall afterwards explain, but as this is one of the first manufactured according to Mr. Ball's improvements, and as it is the only one in England wherewith to demonstrate the inventor's ideas, we prefer to devote our attention now to that which is actually before us.

What Mr. Ball's original idea was we cannot say, but it seems pretty evident that his first machine was a kind of

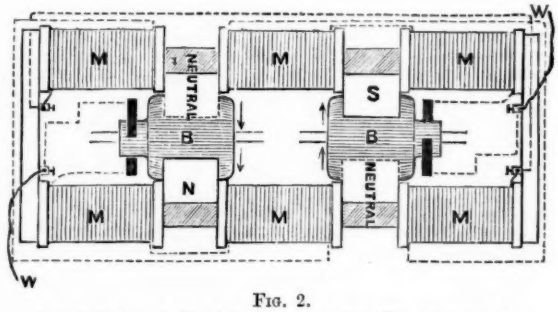


FIG. 2.

W, W'. External circuit wires. M, M. Electro-magnets. B, B, Armatures. N, S. Pole-pieces. The arrows show the directions of rotation.

double Gramme, and that he expected by such a duplicate arrangement of armatures to get a mutual helping effect from them, or, in other words, he doubtless thought he might obtain a given electrical effect with less expenditure of motive power than can be obtained in other dynamo-electric machines. From what we can gather concerning Mr. Ball's

experiments, it appears that when his machine was first tried it failed to give any external effect, either through wrong connections or through the current from one armature opposing that from the other. Afterwards a good result was obtained by revolving the armatures in opposite directions, but it was then found that the connections of the electro-magnets were so arranged that at one side of each armature was a neutral point. These mistakes, if such they may be called, seem to have had the effect of inducing Mr. Ball to abandon one pole piece of each armature entirely, the result being the machine forming the subject of our article.

The electro-magnet cores, which are in this machine placed sideways to the armatures, are of soft iron 7 in. wide by $1\frac{1}{8}$ in. thick. Each core is wound with three sections of wire, one of the spaces forming a strong magnetic pole and the other space a neutral point. It may, perhaps, be advisable to mention here that although the four original pole-pieces may sometimes be seen on this machine, the two, which we may term "dummies," are only kept in their places to give additional support to the bearing or socket which carries the inside ends of the two armature axles. The armatures are 8 inches in diameter, and revolve in opposite directions, and the cores are made up of iron rings metallically insulated. They are each wound with No. 14 (American gauge) copper wire, and the total weight on the two is about 38 lbs. Each armature contains sixty sections, and these are attached to a commutator with the same number of sections in a manner precisely similar to that of Gramme. The periphery speed of the armatures at 1,650 revolutions per minute = 3,450 ft., and this gives six arc lights; at 1,800 revolutions per minute the periphery speed is 3,700 feet, and this keeps seven arc lights in action. Each armature is driven by an 8″ pulley, and by a belt *half an inch* wide.

The weight of copper wire on the electro-magnets is 130 lbs., the total weight of wire on the machine being therefore 168 lbs. This being, however, as we have already said, of the earliest pattern, weighs both in copper and iron about 35 per cent. more than the latest form of machine to produce the same work. The machine which although elongated is very low, is shown supported on extra cast iron stands to render it more easily accessible.

The total weight is about 750 lbs.

Appended is the report of Mr. Robert Sabine's electrical tests on Ball's machine, which will give our readers all the necessary information concerning the electrical details of this apparatus.

[Copy.]

3, Great Winchester Street, London,
March 20th, 1883.

Chas. Ward Raymond, Esq.

Dear Sir,—According to your instructions I have tested the continuous-current dynamo-electric machine of Mr. Ball at present at 41, Kirby Street, Hatton Garden. This machine consists of a long rectangular frame of soft iron, coiled so as to form the field-magnets, and which longitudinally supports the axes carrying two bobbins of the Pacinotti type. The main peculiarity of the machine is that each bobbin is rotated in the presence of only one magnetic pole, the opposite side of the bobbin facing a neutral point of the field; hence the name "unipolar," by which the inventor designates his dynamo. The effect of this so-called unipolar arrangement, in so far as the field is concerned, appears to be that the rectangular soft iron frame is converted into two long electro-magnets with two poles—only one being presented to each of the rotating bobbins—instead of into four shorter and proportionally weaker electro-magnets, having four poles, as in the ordinary way, by which two opposite poles would be presented to each of the bobbins.

When I tested the system the dynamo was run with six arc lamps, also said to be of Mr. Ball's invention, the dynamo being worked on the "series" system—that is to say, field-magnets, armatures, and lamps all joined up in series. The speed of the machine was not so regular as could have been desired, and the Morin dynamometer, by which the power given to the dynamo was measured, would have worked steadier had it been driven quicker or with a heavier load.

The following are the mean results which I found:—

Current in circuit, $c = 15{\cdot}0$ ampères.
Potential difference between terminals, $E = 195$ volts.
Resistance of dynamo, $r = 4{\cdot}5$ ohms.
Speed of dynamo 1,650 to 1,715 revolutions per minute.
Speed of dynamometer, $s = 332$,, ,,
Indicated pull on dynamometer, less pull when circuit open, $k = 52$ kilos.

From these values—

(1.) Given to dynamo for electrical work

$$\frac{1{\cdot}5\ k.s.}{60 \times 76} = 5{\cdot}68 \text{ H. P.}$$

(2.) Accounted for in outer circuit

$$\frac{E\,c}{746} = 3{\cdot}92 \text{ H. P.}$$

(3.) Accounted for in inner circuit

$$\frac{c^2\,r}{746} = 1{\cdot}35 \text{ H. P.}$$

The proportion accounted for electrically, therefore,

$$\frac{5{\cdot}27}{5{\cdot}68} = 0{\cdot}92$$

of which $\frac{3{\cdot}92}{5{\cdot}68} = 0{\cdot}69$ was accounted for in the lamps. This would leave only 8 per cent. for the so-called Foucault currents.

Photometric measurements were made with one of the lamps, placed apart from the others in a dark recess, the light of the five remaining lamps not being measured.

The following mean results were obtained during the observations:—

Current in lamp ... ... 13·9 ampères.
Potential difference ... ... 40·1 volts.
Accounted for in lamp

$$\frac{13{\cdot}9 \times 40{\cdot}1}{746} = 0{\cdot}75 \text{ H. P.}$$

The illuminating effects were as follows:—

Position of arc with regard to photometer.	Illuminating power.	
	Observed.	Per 1 H. P. accounted for in the lamp.
	Standard Candles.	Standard Candles.
22° below	602	802
11° do.	626	835
Horizontal	887	1,183
11° above	1,213	1,617
22° do.	1,831	2,441
31° do.	1,859	2,479
35° do.	1,690	2,253

Yours faithfully,
(Signed) ROBERT SABINE.

So far we have dealt entirely with the 6-light machine, but Mr. Raymond gives us the following information concerning the 15-light machine now in use in New York City:—

Two armatures, 12 in. dia., No. 14 (Am. gauge) wire, 3,000 ft. each	80 lbs.
Six magnet bars, 2 in. × 2 in. each (three on top, three on bottom), No. 8 wire, 4,444 ft. each	200·5 ,,
Total weight of copper on machine	280·5 lbs.
Total weight of iron	661 ,,
Copper in two commutators	30 ,,
Bearings (composition)	26 ,,
Total weight of 15-light machine	997·5 lbs.

Weight of machine per lamp, 66 lbs.
Internal resistance of machine, about 7 ohms.

Two armatures, two commutators on one shaft revolving in same direction, but with connections so coupled as to give same effect as in 6-light above-mentioned, and with but one pole piece to each armature. With a periphery speed of 3,600 ft. per minute (= 1,146 revolutions) gives 15 arc lights. With a periphery speed of 4,000 ft. per minute (= 1,274 revolutions) gives 18 arc lights. One belt $2\frac{1}{2}$ inches wide. The above from actual trials.

The latest machine, by advices from New York City, has the following description:—

Five-Light Dynamo.

Total weight of copper on field and armatures	88 lbs.
Total weight of machine (about)	350 ,,
Weight of machine per lamp (about)	70 ,,

Revolutions 1,190 per minute give five arc lights.

Two armatures (with but one pole-piece to each armature) and but one commutator, mounted on one shaft and revolving in the same direction, with one belt.

The commutator has 120 sections, the armatures have 60 sections. The "sparking" is *nil*, and the commutator wears to a polish.

In a future number—perhaps next week—we hope to enter into the action of this machine. In the meantime, should any of our subscribers be inclined to favour us with their ideas on Ball's "unipolar" dynamo-electric machine we shall be glad to entertain their opinions.

Note.—The dynamo at Kirby Street has been running in New York City and in London for a greater part of the time during the past twelve months, *and has had* no *repairs*, and has been taken apart but once, and then for the purpose of cleaning and painting previous to its shipment from New York to London. This freedom from repairs is due to the simplicity of construction and the commercially low speed at which it is run.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Letters, &c., for the "Correspondence" columns should arrive not later than Tuesday morning if they are desired to appear in the following number, such communications to be addressed to the "Editors," ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C.

Letters respecting Advertisements, Subscriptions, &c., should be sent to the "Publisher," ELECTRICAL REVIEW, at above address.

SUBSCRIPTION RATES.

THE ELECTRICAL REVIEW can be had, by order, from any newsagent in town or country; or it can be supplied direct from the office on the following terms (payable in advance):—

Half-yearly (postage included)	9s. 9d.
Yearly ,, ,, ...	19s. 6d.

FOREIGN SUBSCRIPTION RATES.

To all foreign countries (except those mentioned below):—

Half-yearly (postage included)	10s. 10d.
Yearly ,, ,, ...	21s. 8d.

Exceptions:—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia *vid* Brindisi, Philippine Islands, Singapore, Zanzibar, to which places the rates are:—

Half-yearly (postage included)	11s. 11d.
Yearly ,, ,, ...	23s. 10d.

Vol. XI., handsomely bound, in cloth, gilt, now ready. Vols. 1, 2, 5, 6, 7, 8, 9, 10, can likewise be had.

A few complete sets also may yet be obtained. Prices on application to the Publisher.

Cloth cases for binding THE ELECTRICAL REVIEW supplied.

ADVERTISEMENTS.

The rates for Advertisements may be obtained on application to the Publisher, ELECTRICAL REVIEW, 22, Paternoster Row, London, E.C.

Cheques and Post-office Orders (on Chief Office, London) to be made payable to H. ALABASTER.

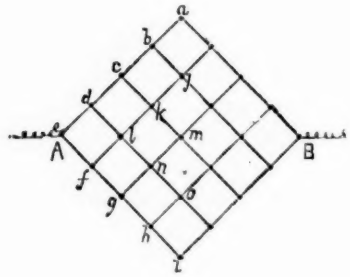
CORRESPONDENCE.

Combined Resistances.

Can any of your readers give me solutions to the two following problems?

(1) The resistance of one side, *a e* (fig. 1), is 1; what will be the resistance from A to B, or of any similar arrangement?

FIG. 1.



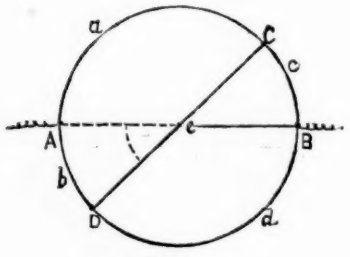


FIG. 2.

(2) Call the resistance of the diameter, C D (fig. 2), 1; what will be the resistance between the points, A B, when this diameter is placed as shown, and how will the resistance vary as the wire is turned through 180°?

Joseph Brearley.

56, Walton Street, Brompton, S.W.

[In reply to the above queries we give the following:

(1) Referring to fig. 1, since this figure is perfectly symmetrical, we can join the points *d*, *f* together, also the points *c*, *l*, *g*, also the points *b*, *k*, *n*, *h*, and also the points *a*, *j*, *m*, *o*, *i*, without affecting the resistance of the arrangement. If we suppose this to be done, then calling the resistance of each of the sides of the small squares, *r*, we have—

Joint resistance of $e\,d$ and $e\,f$ ... ... $= \frac{r}{2}$

,, ,, $c\,d$, $d\,l$, $l\,f$, and $f\,g$ ... ... $= \frac{r}{4}$

,, ,, $b\,c$, $c\,k$, $k\,l$, $l\,n$, $n\,g$, and $g\,h$ ... $= \frac{r}{6}$

,, ,, $a\,b$, $b\,j$, $j\,k$, $k\,m$, $m\,n$, $n\,o$, $o\,h$, and $h\,i$ $= \frac{r}{8}$

therefore the combined resistance of the whole arrangement between the point A and a line joining *a* and *i* will be—

$$\frac{r}{2} + \frac{r}{4} + \frac{r}{6} + \frac{r}{8},$$

and the combined resistance between the points A and B will be—

$$2\left[\frac{r}{2} + \frac{r}{4} + \frac{r}{6} + \frac{r}{8}\right] = r\left[1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4}\right].$$

If the side of the large square had been divided into *n* parts instead of into 4, as in the figure, then the combined resistance of the arrangement would have been—

$$r\left[1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \ldots + \frac{1}{n}\right],$$

and if we call the resistance of the side of the large square, 1, then the combined resistance, R, will be—

$$R = \frac{1}{n}\left[1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \ldots + \frac{1}{n}\right].$$

Thus, for example, suppose the side of the square was divided into 6 parts, then the combined resistance of the whole arrangement between the points A and B would be—

$$R = \frac{1}{6}\left[1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6}\right] = \frac{49}{120}.$$

(2) Referring to page 361 of the No. of the ELECTRICAL REVIEW for November 15th, 1874, we see that the resistance, R, of the figure (fig. 2) between the points A B is given by the equation—

$$R = \frac{e\,[(a+c)\,(b+d)] + a\,b\,(c+d) + c\,d\,(a+b)}{e\,[a+c+b+d] + (a+b)\,(c+d)}.$$

Now, in fig. 2, we have $d = a$ and $b = c$, therefore

$$R = \frac{e\,[(a+c)\,(a+c)] + a\,c\,(a+c) + a\,c\,(a+c)}{e\,[a+c+a+c] + (a+c)\,(a+c)}.$$

$$= \frac{e\,(a+c) + 2\,a\,c}{2\,e + a + c}. \qquad (A)$$

Now $2\,(a+c) = \pi\,e$, or $a + c = \frac{\pi\,e}{2}$. (1)

Also $c = \frac{\theta^0}{180^0}\,(a+c)$, or $c = \frac{\theta^0}{180^0} \cdot \frac{\pi\,e}{2}$. (2)

By subtracting (2) from (1) we get—

$$a = \frac{\pi\,e}{2} - \frac{\theta^0}{180^0} \cdot \frac{\pi\,e}{2} = \frac{\pi\,e}{2}\left(1 - \frac{\theta^0}{180^0}\right), \qquad (3)$$

and by multiplying (2) by (3) we get—

$$a\,c = \frac{\pi^2}{4} \times \frac{\theta^0}{180^0}\left(1 - \frac{\theta^0}{180^0}\right).$$

Substituting this value of $a\,c$, and the value of $a + c$ given by equation (1), in equation (A) the latter becomes—

$$R = \frac{e\,\frac{\pi\,e}{2} + \frac{\pi^2}{2} \cdot \frac{\theta^0}{180^0}\left(1 - \frac{\theta^0}{180^0}\right)}{2\,e + \frac{\pi\,e}{2}}.$$

Or, since *e* is to be equal to 1—

$$R = \frac{\pi\left[1 + \pi\left(\frac{\theta^0}{180^0}\right)\left(1 - \frac{\theta^0}{180^0}\right)\right]}{4 + \pi}$$

From this equation, by giving θ^0 different values, we can obtain the corresponding values of R.

Thus if $\theta^0 = 90^0$, then—

$$R = \frac{\pi\left[1+\pi\left(\frac{1}{2}\right)\left(1-\frac{1}{2}\right)\right]}{4+\pi} = \frac{\pi}{4}.$$

If $\theta^0 = 0^0$, then—

$$R = \frac{\pi\left[1+\pi\left(\frac{0^0}{180^0}\right)\left(1-\frac{0^0}{180^0}\right)\right]}{4+\pi} = \frac{\pi}{4+\pi}.$$

The truth of which is obvious in both cases.—EDS. ELEC. REV.]

Metallic Microphones.

I have read with great interest the paper read before the Society of Telegraph Engineers and of Electricians, by Mr. J. Munro, on "New Telephone Transmitters," published in the Review on the 17th instant, the more so because the writer confirmed the theory which I adopted in making a series of experiments in the fall of 1881. I briefly describe some of these experiments, which, perhaps, you may think worthy of a place in your columns.

One experiment was made with a disc of tin resting on three points, two of which were tin, and the third ebonite; the tin points insulated from each other, and forming the usual terminals between an induction coil and battery, with a resistance of 1,000 ohms in the circuit. The first words, spoken in an ordinary tone, were "What's the matter?" and were distinctly heard, but rather low in tone. I then placed a weight of ¼ oz. on the tin disc, and the tone was more full. The instrument remained in this position five or six hours, and then, when spoken to, only a slight rumbling sound was heard; upon shaking the disc the words were again distinctly heard.

I then substituted for the two tin points two platinum points taken from an ordinary Morse key, and used a disc of polished steel; and this arrangement gave better results. I then glued to the flat surfaces of two blocks of wood, about one half-inch square, pieces of foil taken from a package of tobacco, these two blocks forming the usual terminals; and on these two blocks I placed a disc of wood, ⅛ inch thick, having a piece of foil glued to it; the same words were spoken on to the disc, and they were distinctly heard; at the same time there were snapping sounds, showing breaks of contact; on repeating the experiments in the dark, sparks were visible.

In all these experiments there was no diaphragm or tympan used, and the voice fell directly upon the discs; two cells, No. 2 Leclanché, were used, and a resistance of 1,000 ohms.

I then experimented with pencils of different materials, having metallic ends resting in holes lined with metal, and this arrangement I found gave better results than the metallic disc.

This last arrangement I embodied in my patent, No. 4905, November 9th, A.D. 1881, the claim for which is in the following words:—"In an instrument for transmitting undulatory currents of electricity by means of sound, a combination of pencils of wood, ebonite, bone, or other suitable materials with a capsule of hard tin or of any hard metal fixed on each end of the pencils, the exterior surface of the capsules being roughened, and the capsules on each pencil connected together by any good conductor, in combination with blocks or bars of wood, bone, ebonite, or other suitable non-conducting material, with discs sunk in them, in which are fitted capsules of hard tin or other hard metal, the inside surfaces of these capsules to be roughened, substantially as and for the purposes set forth."

W. C. Barney.

The Telephone.

In the columns of your valuable journal of 21st March, I notice the correspondence under the *nom de plume* of "Das Telephon." Permit me to ask the question, If this correspondent is intending to give a disinterested history of the state of the art in connection with telephones that are free from the claims of Professor Bell's patent? If so, why did he omit such patents as Professor Silvanus P. Thompson, No. 2578, 1882; Messrs. Alabaster, Gatehouse & Kempe, 2675, 1882; and Mr. José D. Husband's, 3008, 1882; and perhaps others? It would appear as if he was interested to the extent of advertising some well "hawked" patents. Allow me to ask the following questions of your corrospondent:—

I. Has he sold any patents lately to a large telephone company for a small consideration, with an agreement not to take out any more in the telephone line?

II. Why did he do so, if they were superior to and free of the Bell patent?

III. Has he not repeatedly offered patents for any consideration whatsoever, stating that he had improvements that he wished to bring out which were "clear beyond all question"?

IV. What were those improvements, and who did they belong to?

V. Has he not repeatedly expressed the opinion that all of the above patents were "unquestionably free" of the Bell patent?

All telephone men appreciate and invite all frank and honest discussion, but the correspondence of "Das Telephon" appears to be very much as a handle to a jug—only upon one side. It would be interesting to hear the other.

Return Circuit.

Electric Light Leads.

An error, sufficiently obvious to most readers, occurs in my letter of last week, which I think must be due to the printer.

For $$d = \sqrt{c \times \frac{\cdot 135}{2\cdot 24}} = \sqrt{c \times \cdot 06}.$$

read $$d = \sqrt{c} \times \frac{\cdot 135}{2\cdot 24} = \sqrt{c} \times \cdot 06.$$

The calculation given assumes that the cost of the conductor depends entirely upon the weight of copper which it contains. It need scarcely be pointed out that for practical calculations the cost for insulating with a suitable covering and laying down must also be taken into account. For branch wires the modification might be slight, but for mains which have to be laid under the streets it is unlikely that the cost of these items will be any function of d^2, since insulating and laying a conductor of double weight of copper does not imply twice the expense.

In any case the loss due to interest on capital sunk must equal the loss due to heating the conductors if we are to obtain the most economical results; and as affecting the size of conductors, there have to be considered the cost of purchasing and laying them down, the permanency of the installation, the fluctuations of current, and the price of coal in the district. If the current fluctuates, the mean square of the current must be taken for the calculations instead of the square.

On the assumption that the cost of the copper represented the cost of the conductor, I mentioned last week that for Mr. Moulton's section to be the most economical coal would require to cost 7d. per ton. Taking the cost of purchasing and laying down conductors of one inch square at £4,000 per mile, and working with a current, the mean square of which for the 24 hours does not exceed $2{,}000^2$, that this section may be the most economical coal ought to cost about 2s. per ton; or, taking coal at 12s. per ton, this section would be the most economical when the mean square of the current in ampères for the 24 hours does not exceed about 900^2. I trust these figures may be of some interest.

E.

City Guilds Electrical Engineering Classes.

I wish to endorse the remarks of your correspondent, "Light," respecting the way in which these classes are still conducted. When the subject was last discussed in your columns, one of the instructors at the college was kind enough to inform the students that "those who could not find accommodation in the laboratories should stay away until the new class-rooms were completed." I, for one, have taken his hint, but having been present at the opening of the new building some little time since, I thought, perchance, I might find an improvement after the change to

new rooms. This, however, was not the case when I looked in one evening recently. My particular wish was to study telephony, but as far as I can ascertain the subject seems to be ignored. It certainly seems to take a long time for the management to set matters in working order.

E. M.

The Court of Appeal and the First Inventor of the Telephone.

On the 10th inst., the Master of the Rolls gave judgment in the appeal taken by Harrison, Cox-Walker & Co., from the decision of Mr. Justice Fry in the case of the United Telephone Company against the appellants.

The judgment confirmed the decision of Mr. Justice Fry, and the United Telephone Company has good reason to rejoice that the Bell patent has been sustained by a judgment pronounced by so eminent a jurist as the late greatly lamented Sir George Jessel, the Master of the Rolls, of whom Mr. Baron Pollock, in announcing this sad and sudden bereavement to his court, said, "I cannot recall any member of the Bench who, in absolute legal learning, in great experience, and in untiring industry, surpassed, or even equalled the learned judge who was so lately among us, and who is now gone."

If the United Telephone Company has reason to rejoice at the decision, the public, and especially inventors, have greater reason to rejoice at the remarks made by the eminent judge, because he therein described the instrument patented by Bell, the full scope of Bell's claim, and judicially quashes the preposterous claim of "any form of magneto-telephone" which the United Telephone Company have had the effrontery to publish to the world, it would seem for the purpose to frighten fools only. The Master of the Rolls held that "what took place at Glasgow" (that was the exhibition by Sir William Thomson of Bell's receiver with the iron disc tilted up) "was a publication of that instrument, a publication of the patentee's own," "published to glorify it."

We have, however, the decision of this eminent jurist that the Glasgow instrument had been published before the date of Bell's patent. At the Glasgow meeting of the British Association, when this instrument was exhibited, Sir William Thomson said, "With this instrument I heard the words, 'To be, or not to be;' 'there's the rub;' 'the Americans in London have resolved to celebrate the coming 4th of July,' as well as other sentences," &c., &c.

At that exhibition no attempt was made to work the instrument, nor did Sir William Thomson say how it was to be worked; and the Master of the Rolls said, "nobody knew how to work it."

Lord Justice Bowen said: "It was argued in the court below, and was contended at one time before us, that the Glasgow instrument, as shown at Glasgow, was of no utility. I think that was a false point, because we have seen it work, and know that it works well; we know now that it is not true that the Glasgow instrument cannot be made to speak even in its present shape."

Three facts are here judicially established: first, the Glasgow instrument was published at the Glasgow exhibition; second, nobody at that time knew how to work it; third, the instrument works well. Now consider these three facts with the following words of the Master of the Rolls: "Though nobody knew how to make a receiving instrument, yet if we are told this is a telephonic receiver that will give articulate sound, it would none the less be a publication because nobody knew how to work it."

It is, therefore, clearly established that a telephonic receiver, say, the Glasgow receiver, capable of giving articulate sounds was given to the public prior to the date of Bell's patent of December 9th, 1876.

If we go no further back it seems well established that Bell was the first inventor of a speaking telephone.

Let us go back, however, to the years 1861-62. At that time Reis made an instrument which he called "Telephon," and in a paper read before the Physical Society of Frankfort in 1861, Reis said he "constructed his instrument for the purpose of transmitting all tones that a human ear can hear," and he said he invented an instrument which should transmit to a distance by the agency of an electric current "the total actions of all the organs operating in human speech."

Mr. Justice Fry in his decision said, "It is perfectly true there is some evidence before me that Reis's instrument will speak."

Let it be admitted for the sake of argument that prior to the trial of Reis's instrument in Mr. Justice Fry's Court, nobody knew how to work it, and apply to it the remarks of the Master of the Rolls, viz., "though nobody knew how to make a receiving instrument, if we are told this is a telephone receiver that will give articulate sound, it would nevertheless be a publication because nobody knew how to work it"; and Mr. Justice Bowen said, "I can conceive an instrument being useless at the time when its use was not known, but which afterwards became useful."

The fact that Reis in 1861-2 made a telephone receiver that will give articulate sounds is judicially established by the decision of these two eminent jurists. I now put it to every fair, honest-minded person, can any one deny that Philipp Reis was the inventor of the first speaking telephone? This fact was, however, clearly established by the facts stated in a communication signed "Das Telephon," published in your Review on 6th January last, and also in a letter to you from me published in your Review 13th January last.

In the words of Prof. Silvanus P. Thompson, "to rob the living of the fruits of their own thought and genius is a crime; to rob the dead is criminality doubly detestable."

I will now refer to the description of Bell's telephone as described in his patent of 9th December, 1876.

The 6th claim in the disclaimer reads, "The combination in the manner described in the fourth and fifth plans of an electro-magnet with a plate of iron or steel, or other material capable of inductive action." In the fourth place, page 10, lines 53-54 of disclaimer, are the words, "such a plate is shown in figure 20, marked A^3, it being attached to a frame, F." And on page 12, lines 55, 56, 57, we find, "The cores or pole-pieces are placed near the face of the metallic plate, A^3, it being attached to a cup-shaped block." This is the description set out in the fourth plan.

The Master of the Rolls said, "The specification tells us there is this thin plate or disc in front of the magnet, close to the magnet, separate from the magnet, *fixed or attached*, and in *such a way as to keep the whole circumference fixed*."

It will be recollected that Mr. Justice Fry, in the judgment he rendered in May last, used these words, "Before considering the anticipations, I think it expedient to describe Bell's receiver as claimed by him and as I understand it. It consists of a horse-shoe magnet, the ends of which are brought into the circuit by means of coils of wire, and in front of which is a metallic plate capable of inductive action, placed at right angles to the length of the magnet, *resting, as regards its circumference*, on the wooden case."

We have, then, the claim of Bell judicially described as an iron plate attached in such a way as to keep its whole circumference fixed; the converse, then, that an iron plate or disc in front of the pole of a magnet, *not fixed around its whole circumference*, is not included in Bell's claims and is free to the public.

It has been thought that Bell's claims, 7 and 8, covered the use of a permanent magnet with coil upon the end, or of a permanent magnet with soft iron pole-piece forming the core with the coils; but both of these claims are for the combination of the plate capable of inductive action *fixed around its circumference*.

Let the United Telephone Company reap all the benefits it can from the use of its patent rights, for which it has paid so dearly, and at the same time let it no longer make the preposterous claim to "any form of magneto-telephone."

A few words in regard to the equally honest claim of "any form of transmitter in which carbon or any equivalent substance is employed," set up by it. Edison himself, or rather the Edison Telephone Company by its officers, in their evidence of February 9th, 1880, says:—"Nor do I claim separately any of the parts or arrangements hereinbefore described; but I claim as my invention, 'In an instrument for transmitting electric impulses by sound the combination with a diaphragm or tympan; of electric tension regulators, substantially as hereinbefore described.'"

The claim 9—and this is the only claim left out of the thirty original claims—is for a combination of diaphragm with a tension-regulator. Hence it is clear the use of tension-regulators, even those described by Edison and claimed in

his original patent, *without* a diaphragm, is free to the public. In my humble opinion, the use of a diaphragm in combination with a microphone is an evil to be avoided, because "the secondary movements of the diaphragm interfere materially with the faithful responses of the microphone to the impact of the sound-waves," as set forth in my patent, No. 4,905, A.D. 1881. I am also of opinion that the use of a metallic plate *fixed all around* its edge is the cause of snapping in a telephone.

W. C. Barney.

March 26th, 1883.

Electrical Meters.

Is not the Ayrton and Perry's "Erg-meter," described and illustrated in your issue of the 17th inst., exactly similar to Mr. Boys' current-meter?

The only difference I can discover between the two is that in place of a balance, as in Boys' meter, they make use of a pendulum, or rather, in place of a spring, gravity. Like many others, it possesses a nice name of Greek extraction, which to the ears of many must sound highly scientific. Unlike some others, in Boys' meters there is something which would interest the most sceptical of electricians.

Probably an ordinary dead-beat galvanometer, coiled with fine wire in sections, and provided with a switch to connect them either in series or in multiple arc, could by its deflection be made to give the number of meters in the market!!!

A. E. Conti.

London, *March 20th*, 1883.

NOTES.

Electric Lighting.—An installation of six Pilsen electric arc lamps and 100 incandescent lamps has just been completed on the premises of the Union Society, Oxford, by the Pilsen-Joel and General Electric Light Company, London. The arc lamps are used for lighting the debating hall, the library, the smoking room, and the outside, while the incandescent are placed in the library, entrance hall, telegraphic room, smoking room, and general offices. The power is derived from an Otto gas-engine, provided with a silencing chamber. The dynamo machines are placed in a house specially constructed in the grounds of the Society. The fittings are plain and substantial. The members notice the purer atmosphere, and express the greatest satisfaction with the result, the lamps burning with much steadiness.

Negotiations are going on between the Brush Electric Light Company and the Vienna Town Council respecting the lighting of Vienna. The company offers at its own expense to lay cables in every part of Vienna in return for the exclusive privilege of supplying the electric light there for a period of fifty years, whether for public or private purposes. Public opinion, however, is against such an arrangement, and it appears unlikely that the company will succeed.

Mr. Arnold White, of the Edison Electric Light Company, Limited, writing to the *Times*, under date the 21st inst., says that the draft Provisional Order issued by the Board of Trade bears evidence of a strong desire to facilitate the introduction of electricity into streets and houses for general purposes. At the same time, he states, there are certain essential points for which no provision is made, and restrictions imposed which, in the opinion of the electric lighting companies, must inevitably act contrary to the intentions of the framers of the Act; and points out that when "Mr. Chamberlain was settling the amendments to the Bill introduced in the House of Lords it was resolved, first, that the electric companies should not prescribe their own or any form of lamp; and, secondly, that the charge to the consumer should be, not for light or for work done, but for electricity. Now, electricity used in a commercial sense is almost a metaphysical term. It cannot be stored, delivered, or measured except in the act of performing work. This being so, it would seem the natural course for the electric companies to base their charges not on the number of ampère-hours registered by the meters, which the public do not understand, but on the light supplied or the power used by customers, which provides a unit that the public do understand. But there is a stronger reason for this method of charge in the interests of the public, of the local authorities, and of the electric companies. The Act as it stands is an Act for the perpetuation of bad lamps, and consequent obstruction to economical improvements. At the present time the most economical lamp known requires about ·75 of an ampère of electricity to produce 16 candles of light for a period of one hour. To-morrow a lamp might well be invented which will produce the same amount of light with a consumption of half the quantity of electricity. Under the Act there is no incentive given to the companies or to inventors to supply a more economical lamp, because the only effect of so doing would be that the amount of electricity sold would be less with the better and more economical lamp than is the case with the obsolete and more wasteful lamp. This is a blot so great that unless the methods of charge are revised in such a way as to promote the use of good and economical lamps, the progress of electric lighting will be inevitably hindered in this country."

Mr. J. Kenneth D. Mackenzie, A.S.T.E., in reply to Mr. Arnold White, asks if the companies were to charge for the amount of light they gave to a consumer, how were they to measure it? It was impossible to charge upon the *maximum* number of lights installed, since the number of lamps burning in any one house was continually varying, and no consumer would like to pay upon the *maximum* while using only a mean number of lamps. If a lamp could be produced which would give twice the light for a given current so much the better for the consumer, who surely ought to be allowed to use it; and it was not for an electric light company to say, "We must charge more for the extra light obtained," while providing meanwhile the same quantity of energy, and therefore incurring only the same expense. If the gas companies were to charge for the amount of light supplied and not for the amount of gas, they should have no improved forms of burners giving a better light for the same quantity of gas consumed; since if the householder paid proportionately for his light there would be no incentive to improvement in the burners. Let the electric light companies charge for the amount of energy supplied in ampère-volts or "units," and let the consumers get the most for their money in light and power they could. That would be fair for both parties; only the companies who proposed to supply on the "direct system" practically compelled consumers to use a particular lamp, namely, one to suit their current, from the fact that the potential at any point along their lines was equal.

Mr. Charles Mossop, chairman of the Chelsea Vestry Electric Lighting Committee, and Mr. George H. Stayton, C.E., the surveyor to the vestry, have prepared a joint memorandum upon the rough drafts of the model clauses issued by the Board of Trade on the 26th ult., which are proposed to be inserted in Provisional Orders. The criticisms and suggestions thereon, which they deemed it expedient to make on behalf of the vestry (and in which the Electric Lighting Committee concur) are contained in a letter addressed to the Secretary of the Board of Trade, in which the following observations are made:—"As regards the main features of the Chelsea Electric Lighting Order, the vestry beg to submit that, in accordance with your suggestion, they have discussed the same with Mr. Moulton, and have practically agreed on the proposed area of supply. As to any further points upon which the promoters and the vestry may differ, it may be convenient to reduce them to writing and submit them to the Board of Trade for final decision. In the vestry's letter to the Board of Trade on their objections to the Metropolitan (Brush) Provisional Order (Clause 3, Part B) it was suggested 'that, whenever practicable, a distributing main should be laid under the footway on each side of the street, so as to avoid the interruption of traffic and breaking up of streets which would be occasioned if the lines were laid under the roadway.' This point, the vestry have reason to believe, is also practically agreed on. The vestry suggest that the Board of Trade should add a model clause to this effect, so that, wherever practicable, other districts may secure the benefit of its adoption, whereby uniformity will be obtained."

The applications for Provisional Orders under the Electric Lighting Act made on behalf of Belfast and Northfield have been withdrawn.

The Edison Electric Light Company, it is said, is arranging to increase the number of its lamps at the General Post Office, London, by the addition of 1,500.

The other week we notified the improved lighting of the Edinburgh Waverley Railway Station. We now hear that there is some probability of the Town Council of Modern Athens calling upon the Brush Electric Light and Power Company of Scotland to light Princes Street.

An interesting exhibition took place at the Crystal Palace on Thursday evening, the 22nd inst. The Gülcher Electric Light Company, together with the well-known firm of Messrs. Defries & Sons, gave a private view of their exhibit, which consisted of Gülcher arc and Crookes's incandescence lamps, in combination with the very beautiful and elaborate fittings designed by the latter firm. The Gülcher system was fully described by us long since, and it is supposed by many that the incandescence lamp of Professor Crookes is superior to others in the most important respects. Although on the evening in question the Exhibition was not complete, owing to unforeseen circumstances, yet enough was shown to demonstrate the worth of the exhibitors' endeavours, and probably by the time this notice comes before our readers there will be nearly 600 incandescence and 15 arc lamps in operation, under the superintendence of Mr. F. R. Bennett, the electrician-in-charge. We cannot now describe in detail the designs for electroliers, &c., shown in connection with these lamps, but we can say that all visitors to the Crystal Palace would do well to inspect the *tout ensemble* for themselves. Messrs. Defries & Sons have not figured prominently in electric lighting matters previously, but in their new venture they certainly maintain their reputation long since established in connection with gas-fittings, and this we think sufficient praise.

At the Chelsea Vestry meeting on Tuesday, the rector in the chair, Mr. Charles Mossop, chairman of the Electric Lighting Committee, announced that in company with the surveyor, Mr. George H. Stayton, C.E., and Messrs. Livingstone (surveyor), and Smith (clerk), representing St. George's, they had discussed at length with Mr. Farrer and Mr. Thompson the model clauses prepared by the Board of Trade, and the Board had agreed to modify some of the clauses chiefly on matters of detail. The amended clauses will be ready for the public on Monday.

Dundee Gas Commission and the Electric Light.—A special meeting of the Dundee Gas Commission was held last week—Provost Moncur presiding—to consider the agreement which has been made with the Brush Electric Lighting Company. The clerk read the proposed agreement, which provides that the Provisional Order promoted by the Gas Commissioners shall be withdrawn, and that the Order promoted by the Brush Company shall proceed on condition that the most favoured clauses to any corporation or public body in a similar position to Dundee appearing in any Provisional Order passed by the Board of Trade and Parliament in favour of any company applicable to any town shall be inserted in the Order promoted by the Company; but (1) that the period of purchase shall be fifteen instead of twenty-one years; (2) that the area for compulsory supply shall be extended; (3) that on the requisition of the Police Commissioners the Company shall supply electricity for lighting the streets at a price to be mutually agreed on, or, failing agreement, to be fixed by arbitration; (4) that a requisition requiring the Company to lay distributing mains for the purposes of general supply in any street within the area for compulsory supply may be made by owners or occupiers of premises in such street; and (5) that in the event of the Company failing within four years to provide such works and apparatus as may be necessary for a general supply of electricity, the Order shall stand revoked. The provost said he considered this arrangement satisfactory to the Gas Commission, as well as to the community. It secured that experiments should be made in electric lighting by the company, by whom the expense would be borne. At the same time it conferred no monopoly on the Brush Company. It would take about two years to get the necessary works executed, so that the company would have only thirteen years of actual work, and at the end of that time they were obliged to dispose of their works to the Gas Commission, if the commission thought proper to purchase them; but if not, then the company could go on for another seven years, and again the commission had an opportunity of purchase, and so on every seven years. The area which would be included was much larger than that originally proposed by the Brush Company, and was from Tay Street on the west, to Trades Lane and St. Andrew's Street on the east; and from Dock Street and Yeaman Shore on the south, to Bell Street and Court-House Square and Ward Road on the north. He thought the arrangement was a very favourable one for the community, and he considered the board should approve of it. Mr. James Mitchell also spoke in favour of the agreement, which, he remarked, bound the company to supply electric light to any person within the area who wanted it, at a reasonable cost. After some discussion the meeting approved of the agreement, and remitted to the Special Committee to see its provisions carried out.

The Elphinstone-Vincent Dynamo.—A demonstration of this dynamo was given by Lord Elphinstone and Mr. Vincent on Wednesday week at Messrs. Unwin's works, Ludgate Hill, in the presence of a number of distinguished visitors. Mr. Vincent explained in detail the construction of the machine, in which it would seem that the credit of the engineering arrangements is due to Lord Elphinstone, and that of the electrical disposition to Mr. Vincent. The description was given in a large warehouse on Messrs. Unwin's premises, in which were arranged 300 Swan incandescent lamps of 20 candle-power each, there being 141 more distributed over other parts of the building, the current being supplied from one machine. At the conclusion of Mr. Vincent's address the Swan lamps were extinguished, and the current was switched on to a very powerful arc lamp, showing that either class of lamp can be supplied by the same machine.

The Vienna International Electrical Exhibition.—We have been officially informed by the Austrian-Hungarian railway administrations that they have agreed to grant reductions of freight on all exhibits. These will, according to the different tariffs of piece goods, amount to from 70 to 80 per cent. Insurance to the full value will also be allowed.

Overhead and Underground Wires in Chicago.—The telegraph and telephone engineers who are spinning their gigantic wire web above the streets of London with a supreme disregard for the safety of all below will do well, says the *Pall Mall Gazette*, to take warning by the fate which has overtaken their brethren in Chicago. The city authorities launched an ordinance declaring that every wire must be placed underground by the 1st of May. On the 1st of March, as a preliminary measure, all the wires of the Mutual Union and the Board of Trade Telegraph Companies were cut by the police. The wires of the Western Union will fall two months later, for after April 30th not a single overhead telegraph wire is to be left in all Chicago.

Telephonic Communication.—The *Standard* states that "A test took place on Sunday of a telephone between New York and Chicago, a distance of 1,000 miles, and the result was a complete success. Previously the longest distance over which a telephonic message had been sent was 700 miles, between New York and Cleveland. The present result is not due solely to the telephone, although that possesses some novelty, but is mainly due to a novelty in the conductor. This consisted of a steel wire core, copper-plated, the electrical resistance of which to Chicago was only 1,522 ohms, as against upwards of 15,000 ohms, the average resistance of ordinary iron telephonic wire. This new achievement is regarded as marking a new era in the development of telephonic communication."

[Although the result obtained is interesting, it can hardly be regarded as a remarkable feat. The question of long telephoning as solved in the manner described is purely a matter of capital, for provided the conductor resistance per mile of a wire is made low enough, distance is almost im-

material; but such a low resistance can only be obtained by employing one of a large diameter and high conductivity, and of a consequently high cost.—Eds. Elec. Rev.]

Electric Ventilation of the District Railway.—"M. C. B.," in a letter on this subject, dated the 21st inst., in the *Daily Telegraph*, calls attention to the suggestion made by Prof. Ayrton, of the City of London Technical College, in his lecture the other day at the London Institution, that ventilating fans should be used to clear the tunnels of their smoke and steam. A fan of that kind could be driven by electricity generated by steam-power at any convenient distance. All that it needed was a wire conveying the current, which might be of any required strength. It was well known that the ventilation of collieries by means of powerful revolving fans had been of enormous service; and in these days, when the problem of transmuting steam-power into electric energy had been so fully mastered, and that of transmitting it, with the smallest loss, so fairly solved, there seemed to be no reason why the same process should not be applied to these tunnels. At any rate, says "M. C. B.," Prof. Ayrton's scientific eminence, and the success with which he has worked out the problem of applying electricity to the daily uses of life, warrant the suggestion that his proposal should be carefully examined.

French Electricians.—A Paris correspondent of the daily press writes that a monthly dinner of electricians has been started, under the auspices of Count Hallez d'Arros, and that the inaugural meeting took place on the evening of Wednesday week, with M. Cochéry, Minister of Post and Telegraphs, in the chair. As the company consisted exclusively of electricians, gas was naturally eschewed, and the lighting was effected entirely by electricity, furnished by Faure accumulators, which were brought in a cart, and communication with which was effected in a few minutes. A central chandelier hung from the ceiling and four handsome candelabra on the table proved amply sufficient for all requirements, while the absence of heat was found to be a great recommendation. The object of Count Hallez d'Arros in starting these monthly dinners, was explained by him in his speech to be to afford an opportunity for scientific and commercial men, both equally interested in electricity from different points of view, to meet and exchange their views.

The Faure-Sellon-Volckmar Accumulators.—Messrs. Norman & Son, engineers, electricians, and contractors, Glasgow, write us:—"We notice in the report in your issue of the 24th inst. of the annual general meeting of the Electrical Power Storage Company, that the chairman mentions the various firms who have been supplied with accumulators. May we beg to call your attention to the fact that we received the first set of the Faure-Sellon-Volckmar accumulators sent to Scotland, and have since had them in daily use in exhibiting the electric light in our offices here, and further that we lent them to Professor Ayrton for his lecture on electrical locomotion at the St. Andrew's Halls, Glasgow, on the 8th February last?"

Query.—Can any of our readers inform us of the existence of any books or articles on the subject of "Telegram Condensation"? There is one book we know of—*Dictionnaire Télégraphique Economique et Secret*, by H. M. Gallian, Paris, 1874, and there are probably many "Codes": but these aim primarily at secrecy, not at condensation.

Telegrams for the West Indies, &c.—The cables between Trinidad and Demerara, and between St. Vincent and Grenada, have been repaired.

Royal Scottish Society of Arts.—At a meeting of this Society, held on Monday evening, Professor Blyth, of Glasgow, read a paper "On the Practical Measurement of Electric Currents and Electromotive Forces." After referring to the need which had recently sprung up in connection with electric lighting for accurate and handy forms of galvanometer and voltameter, Professor Blyth went on to explain, with the aid of models, a form of galvanometer called a solenoid galvanometer, which he had recently devised. It consisted essentially of a solenoid placed vertically, in the axis of which a hollow core of thin, soft iron was free to move vertically. The electro-magnetic attraction of the solenoid on the core was balanced by the extension of a spiral spring; and the current was deduced from the extension of the spring, as measured on a millimeter scale, required to raise the core to a certain fixed mark. It was mentioned that, by means of a shunt arrangement, currents from about a tenth of an ampère to 90 or 100 ampères could be measured by this instrument. After stating his method of graduating the solenoid galvanometer, Professor Blyth next explained a form of electrolytic current-meter, which he had recently invented in connection with Mr. D. Bruce Peebles. In this instrument the mixed gases produced by the electrolysis of water were made to pass through the drum of an ordinary gas meter, whose revolutions indicated the number of cubic centimetres produced. From this the total quantity of electricity passing through the circuit was deduced. While explaining this meter, Professor Blyth exhibited a handy and compact form of weight voltameter, constructed by Mr. Laurence Ledingham, one of his laboratory students. He had found this instrument very useful for graduating the above-mentioned instruments. A new form of voltameter was also described, depending essentially on the same principle as the galvanometer. At the close of the discussion which followed the reading of the paper, a vote of thanks was accorded to Professor Blyth.

Superintendent under the Electric Lighting Act.—The appointment of superintendent to carry out the provisions of the Electric Lighting Act has been conferred by the Board of Trade on Major R. Y. Armstrong, R.E., Chatham.

Post Office Telegraphs.—The gross amount received by the Post Office in respect of telegraphic messages during the year ended March 31st, 1882, was £1,616,799. The balance to meet interest on stock created on account of the telegraph service and the redemption of debt was £213,892. There was, however, a deficiency of revenue to meet interest on telegraph stock created of £112,524. The total deficiency to the 31st March, 1882, was £1,330,350.

Telegraph Steamer.—The telegraph steamer *Viking*, which was damaged about three weeks ago by striking the protection wall at Dundee, was, after being repaired launched off the patent slip on Thursday last. On Monday, she made a very successful trial trip.

NEW COMPANIES REGISTERED.

Telepherage Company (Limited).—Capital £50,000, in £10 shares. Objects: To purchase the letters-patent of Professors Fleeming Jenkin, F.R.S., W. E. Ayrton, F.R.S., and John Perry, M.E., relating to telepherage, or automatic, or other transport by electricity, electrical motors, and other matters. Signatories: *F. Jenkin, F.R.S., C.E., Edinburgh, 100 shares; *M. R. Pryor, 12, Great Winchester Street, 200 shares; C. Barclay, M.I.C.E., 12, Great Winchester Street, 50 shares; W. E. Ayrton, F.R.S., City and Guilds of London Technical College, 50 shares; J. Perry, M.E., City and Guilds of London Technical College, 50 shares; G. T. B. Wigan, 2, Brick Court, Temple, 10, shares; *E. J. A. Balfour, 32, Addison Road, 150 shares. Directors, other than subscribers, are required to hold shares of the nominal value of £500. Registered 21st inst. by Bircham, Drake, Burt & Co., 26, Austin Friars.

Liepmann Carbon Company (Limited).—Capital £30,000, in £100 shares. Objects: To purchase the British and foreign patents of Hy. Liepmann for improvements in the manufacture of carbon for electric lighting, and to carry on the business of electricians and electrical engineers. Signatories (with 10 shares each): *C. T. Jacoby, *J. H. Jacoby, and *J. A. Jacoby, of Nottingham; *Gustav Liepmann, *Paul Liepmann, and *Richard Liepmann, of Glasgow; *Hy. Liepmann, Ph.D., F.C.S., 140, Leadenhall Street. Registered 27th inst. by R. Jordan, 120, Chancery Lane.

* Signatories whose names are preceded by an asterisk are also directors.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1882.

3434. "Electric meters." C. V. BOYS. Dated July 19. 6d. Relates to an improved construction of the electric meter apparatus described in Patent Specifications, No. 4472 (1881) and No. 513 (1882), the object in view being to render it more simple and more readily adjustable to various conditions as well as to render it more regular and efficient in its action.

3458. "Telephonic apparatus." J. E. CHASTER. Dated July 20. 6d. Relates to the apparatus described in the number of the ELECTRICAL REVIEW for September 2nd, 1882.

3513. "Telephones." SHELFORD BIDWELL. Dated July 25. 2d. This invention relates to apparatus for reproducing sounds, and particularly the complex articulate sound of the voice from currents of electricity which have been rendered intermittent or undulatory by the action of an ordinary transmitting telephone or microphone. A quantity of insulated wire is wound around a flat hollow bobbin of the form commonly used in galvanometers and needle telegraph instruments, but the width of this bobbin in proportion to its length may be less than is usual in such instruments. Inside the bobbin and in the place which would be occupied by the magnet of the galvanometer or telegraph instrument is a light magnetised bar, which may be conveniently made of clock spring. This, however, instead of being pivoted upon its centre in the ordinary manner is fixed at one end in such a way that it is capable of vibrating like a "free reed" in a direction parallel to the axis of the bobbin. When at rest the magnetised bar should be parallel to the insulated wires, and if it is not made of clock spring or is not sufficiently flexible to vibrate it should be furnished with a short length of flat spring at the end which is to be fixed, so that vibration is rendered possible. If now a current of electricity is passed through the wire a force will act upon the magnetised bar tending to deflect it in a direction at right angles to the length of the wires, and the stronger the current the greater will be this force. Hence when a current of rapidly varying strength, such as that produced by a transmitting telephone is passing through the wires, the magnetised bar is caused to vibrate in a manner corresponding with the variations of the current and thus to reproduce sounds similar to those by which the transmitting telephone is affected. Owing, however, to the smallness of the surface of the vibrating bar the intensity of the reproduced sound is generally feeble, and it is found advantageous to connect the free end of the bar with the centre of a diaphragm or drum head, which may be made of paper, vegetable or natural parchment, thin metal, or other suitable material. This arrangement not only greatly increases the loudness of the sounds, but also adds to their clearness by checking the natural isochronous vibrations of the spring. It is evident that the invention as above described may be modified in many ways. Thus the vibrator instead of being itself a spring may be attached to a spring base. It may be a permanent magnet simple or compound, it may be magnetised by induction, it may be an electro-magnet, or it may be covered with coils of insulated wire which are in the same circuit as the line and the bobbin wires. The form of the bobbin may also be varied and other alterations made without affecting the spirit of the invention. (*Provisional only.*)

3520. "Arc electric lamps." A. L. LINEFF. Dated July 25. 6d. Consists of improvements in arc electric lamps, and its objects are:—1. To effect an automatic feed, so as to cause the points of the carbon electrodes to approach each other exactly in proportion to their consumption, and thus maintain a constant length of voltaic arc. 2. To dispense with clockwork or similar mechanism in the lamp, and thus reduce the working parts to a few pieces. 3. To construct lamps which, by using bobbins of suitable resistance, can be worked with continuous or alternating currents, one or many in a circuit, and so adapted that they can be put in series or in multiple arc, or partly in series and partly in multiple arc, like the separate cells of a battery, thus providing means of adjusting the resistance of the working or external circuit to the internal resistance of the generator of the electric current. 4. To construct a lamp with two or more pairs of carbons, to be burnt in succession, the voltaic arc being transferred automatically from the pair of carbons just consumed to the next pair, and so on.

3528. "Secondary batteries, &c." C. E. BUELL. Dated July 25. 8d. The invention relates to an improved secondary battery, and it consists of a battery having one or both of its electrodes formed of globular or spherical pieces of lead, carbon, or other suitable material, such form of the pieces enabling the largest amount of surface of a given bulk of material confined within a given space to be exposed to the action of the exciting fluid or electrolyte employed. It further consists in constructing the battery of an outward cell of lead or lead-lined material, and an inner cell of porous material placed within the outer cell, both cells being filled with the globular or spherical pieces of lead, carbon, or other suitable material, and a suitable exciting fluid, or electrolyte, such as salt and water or sulphuric acid and water or other fluid and terminals of the battery consisting preferably of binding posts connected to the outer cell, or to the lining or contents thereof, and to the contents of the inner cell preferably through a plate or wire of lead, carbon, or other suitable material.

3544. "Electric regulator and meter." W. LAING. Dated July 26. 6d. The apparatus consists in an electro-magnet, which, by the passage of an electric current, attracts an armature placed in front of its poles, and establishes then a communication in a circuit. This communication can be arranged so as to open the passage to an electric current, and send this current to an apparatus that it is required to regulate, and this notwithstanding the distance that the two apparatus may be placed one from the other.

3547. "Electric cables." J. G. LORRAIN. (A communication from abroad by J. André, of Paris.) Dated July 26. 6d. Relates to improvements upon the invention communicated in respect of which letters patent were granted to A. W. L. Reddie, dated 15th December, 1880, No. 5268. In the specification to the said former letters patent, there is described a cable consisting of webs each composed of a warp of metallic conducting wires or threads and a weft of textile, or non-conducting material, the said webs when used for telegraphy, or similar purposes being by preference folded and superposed with the interposition of non-conducting material between the layers of conducting material, whilst the whole was conveniently enclosed in a tube, and the insulation rendered complete by surrounding, and filling the interstices of the webs with any suitable insulating composition. According to the present invention in lieu of weaving separately the series of webs which are to form the cable, it is proposed to make the web with alternate conducting and non-conducting portions, and by preference with a wide selvage or border at each edge, of non-conducting material.

3557. "Telephonic apparatus." J. MUNRO and B. WARWICK. Dated July 27. 6d. Relates chiefly to the apparatus described in the pages of the ELECTRICAL REVIEW for March 7th.

3570. "Electric arc lamps." F. M. NEWTON. Dated July 27. 6d. Has for object improvements in electric arc lamps, and has reference to means or apparatus for retarding, modifying, damping, or regulating the motions of the electrodes. For this purpose the inventor employs a hollow cylinder whose interior is divided into a number of compartments by radial partitions, each compartment communicating with those next to it by means of one or more small holes or passages. The cylinder is partly filled with mercury or other suitable fluid, and is mounted on a horizontal axis around which it can turn. When the cylinder is at rest the mercury or other fluid accumulates in the lower part or compartments; but if the cylinder be partly rotated the mercury or other fluid will be carried into such a position that its centre of gravity is no longer in the vertical plane through which the axis passes, and consequently its weight will oppose the rotation. If the rotating force be now arrested, the mercury or other fluid will flow back through the holes or passages, and its centre of gravity will again be situated under the suspension of the cylinder, so that the next motion, after a sufficient interval, will take place under the same conditions as the first. This apparatus may be substituted for the usual train of wheelwork ending in a fly in most forms of electric lamp, to control the motion of the electrodes and prevent them moving sufficiently rapidly to cause the extinction of the light by the carbons coming in contact.

3576. "Distributing and measuring electricity, &c." J. HOPKINSON. Dated July 27. 6d. The improvement principally relates to maintaining the electromotive force on a system of conductors for an electric supply at a fixed potential, but they also relate to reducing the cost of such conductors consistently with efficiency and safety to arrangements for disconnecting the dynamo machines from the conductors, and to improvements in the instruments for measuring the quantity of electricity sent into or drawn from the system of conductors. When electricity is delivered by means of a pair of conductors to a distance from the station where the electricity is generated, there is a fall of potential due to the resistance of such conductors, greater as the current is greater, and if it is desired to maintain the potential constant at the delivery end it is necessary to increase the potential at the supply end as the current increases in a suitable manner. To ascertain the potential at the far end of the conductor, the inventor makes use of a galvanometer differentially wound with two coils, the one coil having a high resistance, as for measuring potential, the other, of very low resistance, conveys the current to the main conductor, and acts in opposition to the high resistance coil. The differential coils may be wound on an electro-magnet, which acts as a relay to ring an electric bell, or set in motion or reverse a small dynamo machine, to adjust resistances or control the speed of the steam-engine for the purpose of keeping the potential on service main conductors constant. An approximation to the same end may be attained by winding on the electro-magnets of the dynamo machines, in addition to the usual coils, whether in shunt or conveying a current from a separate centre, a few coils conveying the current to the main conductor, the effect of such coils being suitably adjusted. These latter coils may be wound on a separate electro-magnet. The above improvements are in part also applicable when the resistance of the main conductors is not so great as to cause any serious fall of potential. For the purpose of economising the cost of main conductors, the inventor places two dynamo machines in series, and places two systems of lamps or other appliances consuming electricity of approximately equal capacity also in series. A main conductor is taken from each extreme pole of the two dynamos, and a smaller conductor from between the two dynamos to points between the two systems of lamps. This intermediate conductor serving to bring back to the central station any electricity required for one system of lamps in excess of that required for the other system of lamps.

3582. "Regulating electric currents and electromotive force." L. CAMPBELL. Dated July 28. 2d. Relates to improved means of regulating electric currents and electromotive force produced by dynamo-electric or magneto-electric machines, and to improved arrangements of appliances therefor. In a dynamo or electro-magnetic machine when in action, the various contact pieces of the commutator are not all of the same electrical potential, and in practice the brushes of these machines are arranged so as to make contact with the commutator at the places of highest and lowest potential. As the current and electromotive force are both proportional to the difference of potential, it is evident that the current and electromotive force produced by these machines depend on the position of the brushes on the commutator. The invention consists essentially in so constructing, arranging, and automatically applying the commutator

brushes in contact with the commutators of the dynamo-electric or magneto-electric machines as to take advantage of the variation of electrical potential in the different parts of the commutator besides those of extreme potential, and by such means to regulate or control the current or electromotive force produced by the machine.

3592. "Secondary batteries." F. J. BOLTON. Dated July 28 10d. The present improvements relate to secondary, or accumulator, batteries, and part of the invention consists in subjecting such batteries while forming or charging or discharging to pressure. And part of the invention consists in improvements in the construction of the vessel or receptacle in which the elements of the battery are placed and contained. And part of the invention consists of improvements in the method of arranging the elements of a secondary battery. And part of the invention consists of improvements in supporting the active material of the secondary battery. And part of the invention consists in the manner in which it is effected, that the connection between the charging battery and the secondary battery shall be automatically made and broken. And part of the invention consists of the method by which connection and communication are provided between the elements of the battery or between the divisions containing the electrolyte; and part of the invention consists in the manufacture of the plates or active elements of the battery.

3655. "Electric lamps." O. G. PRITCHARD. Dated August 1. 2d. Relates to improvements in electric lamps of that class known as the sun lamp, in which the light of the arc is supplemented by the incandescence of a block of marble raised to an intense heat by the arc playing along its surface. And the invention has for its principal object to prevent the wasting away of the carbon electrodes by so enclosing them that after the lamp has been lighted a short time they will be surrounded by an atmosphere which is practically incapable of supporting combustion, so that they will be rendered capable of indefinite duration. (*Provisional only.*)

3665. "Plates of secondary or electrical storage batteries." T. CUTTRISS. (Partly a communication from abroad by C. Cuttriss, of America.) Dated August 2. 2d. Relates to certain improvements in the construction of the plates of secondary or electrical storage batteries. The object of the invention is to increase the capacity of the plates by making them of a porous or spongy nature, and so that the active material shall become a part of the plate and continue throughout its dimensions. (*Provisional only.*)

3681. "Apparatus for facilitating telephonic communication." J. COWAN. Dated August 2. 4d. The object of this invention is to enable a subscriber to use the telephone from any part of a town in which there is a system of telephone apparatus. For this purpose, in addition to the ordinary wires leading from the central telephone offices to the various offices of the subscribers, the inventor erects other wires to various parts of the town with boxes at different points containing telephonic apparatus.

3685. "Dynamo-electric machines." W. R. LAKE. (A communication from abroad by A. C. Sample and F. Rabl, of America.) Dated August 2. 6d. This invention relates to dynamo-electric machines, and more particularly to the construction of the field-magnets; to adjustable arms carrying the brushes; and to automatic electric current regulators or governors for regulating the flow of the current from the dynamo-electric machine; the said regulator consisting essentially in one or more helices or electro-magnets, operating armatures or cores to move part or all of the commutator forward or backward with reference to the induction ring or armature of the dynamo machine, the said helices and mechanism related thereto being secured to, and rotating with, the shaft and armature, part or all of the current generated by the machine passing through the said helices which are in the main circuit.

3689. "Apparatus for regulating the transmission of electrical energy and speed of steam-engines, &c." W. R. LAKE. (Communicated from abroad by M. Levy, of Paris.) Dated August 2. 10d. The chief object of this invention is to provide more efficient means than have heretofore been employed, for insuring that any number of machines or apparatus for producing light, heat, or mechanical power, or for other purposes, placed on the same electric circuit (either in tension or in derived circuits) shall preserve their normal functions whatever may be the number of such machines or apparatus at work; and also for insuring that at any time only the amount of power shall be expended which is required by the number of machines or apparatus in operation.

3700. "Secondary batteries." E. G. BREWER. (Communicated from abroad by Otto Schulz, of Strasburg.) Dated August. 3. 6d. Instead of as hitherto forming the porous layer in the lead electrodes of the so-called "Planté" secondary elements only through the influence of the electric current which, as is known, only takes place very slowly, the inventor, according to this invention, treats the lead electrodes (which may have any desired form and surface) before their employment as such with sulphur, so that a layer of sulphur of lead is formed on the electrodes. The treatment is effected in the simplest manner by placing sulphur on the electrodes and then heating it until the desired layer of sulphuret of lead has been formed.

4407. "Galvanic elements." J. H. JOHNSON. (Communicated from abroad by A. Bernstein, of Berlin.) Dated September 16. 2d. Relates to galvanic elements, the positive electrode whereof consists of an amalgam of an alkali metal, and its object is to render such elements more efficient and to protect the said metal against the oxidising influence of the air. It is known that by the employment of an amalgamated alkali metal, for instance, potassium or sodium, as electrode, a galvanic element of considerable energy may be produced. Nevertheless elements of this kind have hitherto not found any practical use, as on one hand the amalgam speedily oxidises, while on the other hand certain arrangements introduced in order to obviate this inconvenience give rise to an excessive internal resistance. Such elements may, however, be rendered fit for practical purposes in the following manner. The sodium, or potassium amalgam, to which a conducting wire of copper, or other suitable metal is attached, is brought into a small bag, or an envelope, consisting of any cloth which is not affected by the exciting fluid to be employed. As such cloth may be used linen, cotton, or other sufficiently close fabrics made of vegetable fibres. The bag, or envelope, is drawn tightly together around the conducting wire by a string, and it is by preference at this point, coated with stearine, paraffine, resin, or other similar substance in order to prevent its upper end from being soaked by liquid. Finally the envelope is impregnated with a solution of caustic soda, or potass, containing in 100 parts from 30 to 50 parts by weight of the alkali whereupon it is dried. Hereby the fabric becomes so close that it will efficiently protect the amalgam against oxidation by the atmospheric air (which is specially of importance while the element is not in use), whereas, on the other hand, it presents but slight resistance to the galvanic current.

5673. "Construction of electric wires and cables." A. J. BOULT. (Communicated from abroad by R. S. Waring, of America.) Dated November 29. 8d. Relates generally to that class of electric underground and submarine cables, in which the conducting wires are armoured with lead, or other ductile metal, said conducting wires being either embedded singly and separately in a common body of the metal, or arranged in groups surrounded by a metallic wall, or a portion of the wires being embedded in the wall of either a plain or corrugated pipe-like shell, while another portion is arranged through the inner passage way of said shell or pipe. The objects of the invention are

FIG. 1. FIG. 2.

—to produce a strong and durable cable in various modifications of the general class referred to, to secure the maximum amount of protection for the conducting wires with a minimum quantity of encasing metal, thus giving the cable a desirable durability, flexibility, lightness, and economical construction in proportion to its capacity; to facilitate the connection of branch conducting wires with one or more conducting wires of a cable; to provide for the expeditious and efficient joining or splicing of different lengths of cable; to obviate induction of the wires of a cable upon each other; to protect submarine cables from the effects of tides and currents; and to provide an improved conducting wire for cables. Fig. 1 illustrates one form of cable constructed according to the invention. A perspective view of a portion of a lead or other flexible metal pipe, having insulated conducting wires embedded in its walls, is shown. Fig. 2 is a cross-section of fig. 1. The pipe-like casing is indicated by the letter P, the conducting wires by *a*, and their insulated coverings by *c*.

CITY NOTES, REPORTS, MEETINGS, &c.

The Provincial (Brush) Electric Light and Power Company, Limited.

MR. GEORGE OFFOR, the manager, has issued the following circular, dated the 22nd inst., to the shareholders of this company:—

"Referring to the circular addressed to you on the 20th October last, the directors desire me to communicate the following information relative to the progress of the company. It will be in your recollection that as soon as the company was organised the directors adopted measures for obtaining—(1) the powers necessary for supplying electricity under the provisions of the Electric Lighting Act of last session; (2) as complete a system as possible of electrical distribution. With reference to the first point the directors have applied to the Board of Trade for Provisional Orders, under which, if granted, they will be enabled to supply electricity for twenty-one years in the following towns, viz., Norwich, Great Yarmouth, Lowestoft, Cambridge, High Wycombe, Ipswich, Sudbury, Luton, Bedford, and Bury St. Edmunds. With reference to the second point several of the patents mentioned in my circular of 20th October have been granted, and the remainder will be completed in a few weeks; they consist of a secondary battery, of a more perfect description than any hitherto introduced, and which has been worked for more than five months with complete success in the offices of this company; an automatic arrangement for regulating the supply of current to the batteries, in the form of a master cell, which cuts off the current when the accumulators are fully charged, and thus prevents the injury to the plates from the generating of gas, which causes their destruction under other systems; a meter for registering the quantity of current used, and so constructed as to enable householders to ascertain at any moment the consumption of electricity in any form of incandescent lamps employed; a regulator for automatically keeping the current of electricity constant; an improvement in the construction of incandescent lamps, by means of which the duration of the carbon filament is prolonged and the light increased; a lamp holder and switch combined, and a telescopic sliding electrolier, which can be raised or lowered without extinguishing the lamps; a circuit shunter, by which, if a lamp be broken, a reserve lamp can be immediately lighted in its place automatically; an improvement in dynamo machines, providing for currents of different tensions to be taken off at the same time. These valuable inventions have, for the most part, been patented in

the United Kingdom, Canada, South Australia, Victoria, New South Wales, New Zealand, Cape of Good Hope, India, France, Spain, Germany, Italy, Russia, Belgium, Austria, Portugal, Sweden, Norway, and Denmark. In the circular of 20th October last it was mentioned that instead of paying large sums for concessions the directors adopted the principle of obtaining a substantial interest in the above inventions, and this was done by arranging with the patentees for working them on joint account with this company and the Provincial (Brush) Electric Light and Power Company (Limited), which is under the same management. As the business connected with these patents developed, it was found that it could be more conveniently carried on as a separate company in which all the interests involved could be consolidated by an arrangement for the due assignment of the various patents, and in consequence a company has been formed called The Consolidated Electric Company (Limited), with a nominal capital of £100,000 in fully paid-up shares of £1 each, of which the South-Eastern (Brush) Electric Light and Power Company (Limited) holds 20,000 shares as representing its interest in the company. The working capital, to a limited extent, as required, is advanced by the South-Eastern and the Provincial (Brush) Electric Light and Power Companies (Limited) jointly, on debentures bearing 8 per cent. interest, repayable by 50 per cent. of the net profits. The Consolidated Electric Company (Limited) will be managed in the same offices and by the same directors and staff as this company, with James Paxman, Esq. (of Davey, Paxman & Co.) of Colchester, and J. Kincaid, Esq., C.E., of London, as additional directors. A suitable factory has been taken at 67a, Cow Cross Street, London, which is now being fitted with the necessary machinery and plant. The manufacture of the accumulators and other patented articles, besides motors, switches, cut-outs, safety fuses, ammeters, voltmeters, and all kinds of electrical apparatus, will, I hope, be in full operation during next month, when you will be invited to visit the works and judge by personal inspection of the important nature of the business intended to be carried on. The method of electrical distribution adopted by this company will be known as the B. T. K. system, those letters forming the initials of the three inventors, Messrs. Beeman, Taylor, & King. In conclusion, the directors desire me to express the hope that you will use your influence to promote the interests of this company, and that of the Consolidated, in every way in your power, the latter company not being restricted to any district, but prepared to execute orders for all parts of the world. The use of the storage system, not only for the purpose of domestic lighting (for which it is absolutely necessary), but also as the means of supplying motive-power for tramway cars, tricycles, sewing-machines, river boats, &c., &c., is being rapidly developed, and promises to afford the Consolidated Company an immense field for profitable business, besides materially assisting this company in working its important enterprise."

A circular similar to the above, with the exception that the towns mentioned in it are Croydon, Richmond, Canterbury, Rochester, Chatham, Gravesend, Margate, Folkestone, and Maidstone, has been issued by Mr. George Offor, the manager to the shareholders of the South-Eastern (Brush) Electric Light and Power company (Limited).

The Anglo-Spanish (Brush) Electric Light and Power Company (Limited).—The second ordinary general meeting of shareholders was held at the company's offices, 110, Cannon Street, E.C., on the 14th inst., Mr. E. Etlinger, in the chair. The chairman, after going in detail through the balance sheet and profit and loss account, pointed out that the company had only been in existence about six months, during which time the directors had been principally occupied in establishing a proper organisation in Spain, and that the actual business entered into and completed was necessarily limited. The company, however, had a wide field, and good prospects in Spain and the colonies, and negotiations were pending for important contracts, some of which had actually been secured since the date of the report. It was the opinion of the directors that the period of experiment had now passed, and that only such installations should be put up as would yield a fair profit, and he was glad to inform them that such business as they had already completed had left a satisfactory profit upon the amount of money for the time laid out on it. A few questions from shareholders having been answered by the chairman, the report was unanimously adopted, and the meeting closed with a vote of thanks to the chairman and directors for the very efficient and careful manner in which they had carried on the business of the company, and with an expression of approval of the cautious policy they had adopted.

The Direct Spanish Telegraph Company (Limited).—The following is the report of the directors to be presented at the general meeting of the shareholders to-day: The accounts for the half-year ended 31st December, 1882, show a balance to the credit of profit and loss of £7,056 17s. 9d. The receipts, although somewhat inferior to those of the last half-year, are in excess of those for the corresponding period of 1881. In the early part of December, a fault of insulation occurred in the shore end of the Bilbao cable near the Lizard, but it did not interfere with the communication; it was successfully extracted in January. The Barcelona cable was broken down from the 8th to the 31st December. It was satisfactorily and economically repaired, and has since been in excellent working order. The cost of these repairs, £751 9s. 5d., was paid out of the revenue of the half-year. The directors informed the shareholders, by a circular dated 30th November last, that they had concluded an arrangement with the Eastern Telegraph Company to work the direct traffic between England and Spain on the joint-purse system. This arrangement came into force on the 1st December, and has proved satisfactory, securing to this company a revenue during the interruption of the Bilbao cable. After paying the dividend on the preference shares, amounting to £2,921 10s. 0d., and appropriating £200 to the reduction of the preliminary expenses account, there remains a balance of £3,935 17s. 9d. The directors deeply regret that they cannot recommend the payment of a dividend on the ordinary shares, feeling the necessity of carrying the whole of this balance to the reserve fund, owing to the unfortunate interruptions of the Bilbao cable since the 1st January last, the repairs of which have to be provided for. The dividend warrants on the preference shares will be payable on the 2nd April. Mr. Etlinger and Mr. Scott are the directors who retire by rotation, and being eligible offer themselves for re-election. Mr. Herbert R. Duke is eligible as auditor for the present year.

Cable Repairs.—Bombay advices, dated March 9th, mention that the repairs of the Bushire-Jask cable had just been successfully completed by the removal of three faults, one of which appeared to have been caused by the tooth of a saw-fish.

The Maxim-Weston Electric Company (Limited).—Mr. T. R. Comyn has been appointed secretary to this company in room of Mr. F. H. Laudon.

The Brush Midland Electric Light and Power Company (Limited).—The offices of this company have been removed from 31, Lombard Street, to 4, Great Winchester Street Buildings.

The Great Western Electric Light and Power Company, Limited.—Messrs. Frederick Pollak, of 27, Throgmorton Street, E.C., and Charles Bell, of Dashwood House, New Broad Street, E.C., have been elected directors.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid	Closing Quotations, March 28.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	7	6½- 7	6⅞ m.
		Do. Do.	10	9 - 10	9½ m.
30,000	5	Australasian Electric Light, Power & Storage Co.	3	¼- ⅜	
24,000	10	British Insulite Co., Limited, "A" Shares	3	1⅝- 2⅛	
30,000	5	Brush Electric Light & Power Co. (Scotland)	2½	⅛- ⅜	
25,000	5	Great Western Electric Light & Power Co.	2½	⅛- ⅜	
24,980	5	Hammond Electric Light & Power Supply Co.	2½	3½- 4	3¹⁵⁄₁₆ m.
40,000	5	Indian & Oriental Electrical Storage Works Co.	2	¼- ⅜	
172,500	1	Maxim-Weston Electric Light and Power Co.	1	½- ¾	
40,000	5	Pilsen-Joel & General Electric Light Co.	2	¼- 1	
..	..	South African Brush Electric Light & Power Co.	2½	¾- 1¼	
100,000	5	Swan United Electric Light Co., Limited	2½	1⅝- 2⅛	
		TELEGRAPHS.			
2,116,400*l.*	Stk.	Anglo-American, Limited	100	51 - 52	51⅝ ac.
2,441,800*l.*	Stk.	Do. Preferred { Def'd. receiving no div. until	100	83 - 84	83¾ m.
2,441,800*l.*	Stk.	Do. Deferred { 6 p. c. has been paid to Pref.	100	20½- 21	
130,000	10	Brazilian Submarine, Limited	10	12⅝- 12⅞	12¹⁵⁄₁₆ m.
16,000	10	Cuba, Limited	10	9⅞- 10¼	
6,000	10	Do. 10 per cent. Preference	10	16½- 17⅛	
13,000	10	Direct Spanish, Limited	9	5⅝- 6	5⅝ m.
6,000	10	Do. 10 per cent. Preference	10	15½- 16½	
65,000	20	Direct United States Cable, Limited, 1877	20	12½- 12⅝	12⅝ m.
100,000*l.*	100	Do. 6 per cent. Debenture, repayable 1884	100	101 -104	10⅜ m. 11.
380,000	10	Eastern, Limited	10	10⅝-11⅛	10¹¹⁄₁₆ ac.
70,000	10	Do. 6 per cent. Preference	10	13 - 13½	13⅜ m.
232,000*l.*	100	Do. 6 do. Debentures, repayable Oct. 1883	100	100 -103	
200,000*l.*	100	Do. 5 do. do. Aug. 1887	100	100 -103	
200,000*l.*	100	Do. 5 do. do. Aug. 1899	100	104 -107	
199,750	10	Eastern Extension, Australasia & China, Limited	10	11⅜ 11⅞	
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891	100	107 -110	
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900	100	104 -107	105⅛ m.
140,000	100	Do. do. registered, repayable 1900	100	104 -107	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	103 -106	104½ m.
254,300*l.*	100	{ Eastern and South African Limited 5 per cent. } { Mort. Deb. Registered redeemable 1 Jan. 1900 }	100	103 -106	
345,700*l.*	100	Do. do. do. To Bearer	100	103 -103	
22,050	10	German Union Telegraph and Trust, Limited	10	10½- 11	
163,330	10	Globe Telegraph and Trust, Limited	10	6¾- 7	7 m.
163,206	10	Do. 6 per cent. Preference	10	12½- 13	12⅝ m.
125,000	10	Great Northern	10	12½- 12⅝	12½ m.
100,000*l.*	100	Do. 5 per cent. Debentures	100	101 -104	
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	29½- 30½	
100,000	100	Do. 6 per cent. Debentures, 1888	100	105 -108	
17,000	25	Indo-European, Limited	25	32½- 33½	
38,148	10	London Platino-Brazilian, Limited	10	4⅛- 4¼	
12,060	10	Mediterranean Extension, Limited	10	1½- 2	1⅝ m.
8,200	10	Do. 8 per cent. Preference	10	6½- 7½	
9,000	8	Reuter's, Limited	8	10½- 11	
280,000	Stk.	Submarine	100	247 -252	
58,225	1	Do. Scrip	1	2⅛- 2⅜	
4,200	Cert.	Submarine Cables Trust	100	105 -109	
37,350	12	Telegraph Construction and Maintenance	12	32½- 33½	
150,000	100	Do. 6 per cent. Bonds, 1884	100	101 -103	
186,750	5	Do. 2nd Bonus Trust Cert.	5	1⅜- 1⅝	
30,000	10	West Coast of America, Limited	10	4½- 5	
150,000	100	Do. 8 per cent. Debentures	100	107 -109	
69,910	20	Western and Brazilian, Limited	20	7⅝- 8¼	
200,000*l.*	100	Do. 6 per cent. Debentures "A" 1916	100	104 -107	
2,500	100	Do. 6 p.c. Mort. Deb. series B of '80, red. Feb., 1919	100	99 -103	
1,500	$1,000	Western Union of U. S. 7 p.c. 1 Mort. (Building) Bds.	$1,000	122 -126	
1,030,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	102 -105	
88,321	10	West India and Panama, Limited	10	1⅛- 1⅜	1⅜ m.
34,563	10	Do. 6 per cent. 1st Preference	10	7⅛- 8	
4,669	10	Do. 6 do. 2nd do.	10	5⅛- 6	
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. 1 to 154,165	1	⅝- 1⅛	1⅛-1 m.
225,000	1	Oriental Telephone Co., Nos. 80,001 to 305,000	¼	⅜- ½	
100,000	5	United Telephone Co.	5	10½- 11	